THE UTAH GENUINE PROGRESS INDICATOR (GPI), 1990 TO 2007

A REPORT TO THE PEOPLE OF UTAH

A UTAH VITAL SIGNS PROJECT

OF

THE UTAH POPULATION & ENVIRONMENT COALITION

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The analysis and conclusions in this report do not necessarily reflect the views and opinions of those who are acknowledged above or the positions of UPEC. We are solely responsible for the content and any remaining errors in the report.

Günseli Berik and Erica Gaddis

ABSTRACT

This study presents estimates of the Genuine Progress Indicator (GPI) for Utah for the 1990-2007 period to assess the change in quality of life in Utah. Conventional economic measures such the GDP are commonly used as shorthand for improvements in well-being, even though GDP was never intended to be more than a tally of the volume of market transactions in a given year. GPI seeks to correct the flaws of the GDP by providing a full accounting of the contributors to and detractors from the welfare of society, adding not only the “debit” side but also the nonmarket contributors to current income on the “credit” side. This entails starting with a proxy for material welfare—personal consumption expenditures adjusted for income inequality—that provides the basis for an improved quality of life. The monetary value of those activities that contribute to our well-being but are not priced in the marketplace are then added to the measure. These include the nonmarket services of household and volunteer labor, and the benefits of our forests, wetlands, and deserts. Finally, monetary costs of those expenditures we incur to protect our standards of living and the erosions of our natural and social capital are deducted. These include the costs of crime, auto accidents, underemployment, lost leisure time, and pollution. A total of 24 adjustments were included to arrive at the GPI for the State of Utah and 6 of its most populous counties—Cache, Davis, Salt Lake, Utah, Weber, Washington counties.

The main finding of the Utah GPI study is that, overall, quality of life improved in Utah since 1990, but this improvement is overstated by the increase in Utah’s GDP. Generally, the value of economic components of GPI increased while the contribution of social and environmental components slightly declined since 1990. These trends are consistent with findings of earlier studies for Utah. The subjective well-being surveys conducted by Envision Utah indicate that between 1997 and 2007 there was a slight decline in the quality of life reported by Utahns, which is correlated with the decline in social and environmental components of the GPI. The Utah Ecological Footprint study of 2007 showed that between 1990 and 2003 Utah went from an ecological surplus to an ecological deficit, indicating that Utahns now consume more biological resources than our lands produce. This trend, in turn, is consistent with the steady increase in personal consumption activity that uses up biological resources primarily outside of Utah.

Notable findings in individual components of the Utah GPI include the staggering values contributed by nonmarket activities to the Utahns’ quality of life. In 2007 household labor and volunteer labor contributed an estimated value of $14 billion or 16% of the state GDP. The value of services to society provided by our natural environment (ecosystem services) totaled $25 billion in 2007 or about 30% of GDP. Major costs include those associated with driving (commuting, crashes, air quality), which totaled nearly $8 billion in 2007, while lost leisure time (associated with overwork) and underemployment cost Utahns $7.7 billion. Some trends of concern are dependence on the state’s nonrenewable natural resources that are being depleted, increasing commuting time and distance, loss of prime farmland that undermines Utah’s ability to grow its own food into the future. The Utah GPI’s full-accounting framework provides substantial opportunity for informed policy-making.

EXECUTIVE SUMMARY

A MORE USEFUL INDICATOR THAN GDP

Standard measures of economic activity for Utah, such as the GDP, indicate steady economic growth since at least 1963 in both total value and per capita terms. However, many economists and policy makers question the adequacy of the gross domestic product (GDP) as a measure of well-being in either economic or societal terms. While it is widely recognized that GDP was never intended to be a measure of well-being, it is often mistakenly viewed in that manner and therefore frequently used as such. GDP is a tally of all monetary exchanges that take place in a given year. As such, it does not differentiate between economic activities that add to our well-being and ones that undermine our quality of life. Nor does GDP take into account the contributions of nonmarket services of individuals or the environment to our well-being. Currently GDP improperly counts consumption of natural resources or economic processes that erode social cohesion as improved economic welfare. Thus the GDP approach is sometimes referred to as “positive ledger only accounting,” akin to reporting only total revenues of a business in an income statement, neglecting to take into account either the expenses or the depreciation of the company equipment. Any improvement to this approach is real progress in national or state income accounting.

We propose the Genuine Progress Indicator (GPI) metric as a useful new indicator for Utah. The GPI provides an integrated and holistic framework that seeks to correct the flaws of national and state income accounting by implementing a full accounting of the welfare of society. This entails both adding those things that contribute to our well-being and deducting market transactions that do not contribute to well-being. The primary goal of the GPI study is to determine whether economic growth in Utah, as measured by traditional metrics, has led to genuine social, economic, and ecological progress in the past 20 years. GPI takes a closer look at the condition of aspects of our community that contribute to or detract from our individual well-being and quality of life. In that sense, GPI provides a broader assessment of our overall welfare.

MEASURING QUALITY OF LIFE, NOT JUST ECONOMIC TRANSACTIONS

GPI is an objective quality of life metric that assesses current net income by incorporating adjustments for economic, environmental, and social values and costs. Examples of these adjustments include the value of non-market work; the monetary costs associated with activities such as commuting, automobile accidents, pollution, and crime; and the value of services provided to society by natural capital, such as wetlands, cropland, and forests. Each of these considerations is reflected in monetary terms as a component of the GPI. Thus, GPI is a single number indicator that can also be broken down into components. As such, GPI can be tracked over time and compared to other states and nations.

While the GPI accounting framework provides a monetary measure of our quality of life, underlying the monetary value or cost represented by each of the components of GPI are also nonmonetized indicators that are known constituents of well-being. Each of these components has an account that describes the condition and trends in the component in both nonmonetary and imputed monetary terms. For example, the GPI framework evaluates changes in emissions of air pollutants as well as assessing the changes in their cost in monetary terms. This cost, in turn, is deducted from our overall GPI. Thus, compared to the GDP we are able to obtain a more compelling picture of contributors to our quality of life and how it is changing.

BETTER POLICY COMES FROM BETTER DATA

The Utah GPI study provides substantial opportunity for local policy makers to make informed policy choices that take into consideration a broad range of factors beyond the economic considerations. In addition, the GPI framework fits in well with other values-driven planning processes, such as the activities of Envision Utah or Utah's Quality Growth Commission, which seek to promote quality growth in the state. GPI accounts help decision-makers answer the question: Is Utah's economic growth leading to genuine social, economic, and ecological progress? In particular, the Utah GPI study provides a quantitative framework by which policy options could be compared and prioritized by local decision makers by taking into account social, economic, and environmental factors. For example, components of the GPI such as the cost of vehicle accidents, commuting time, air pollution, and the loss of open space could inform transportation planning. Because the results are reported in uniform monetary units, they can be used to directly assess economic tradeoffs.

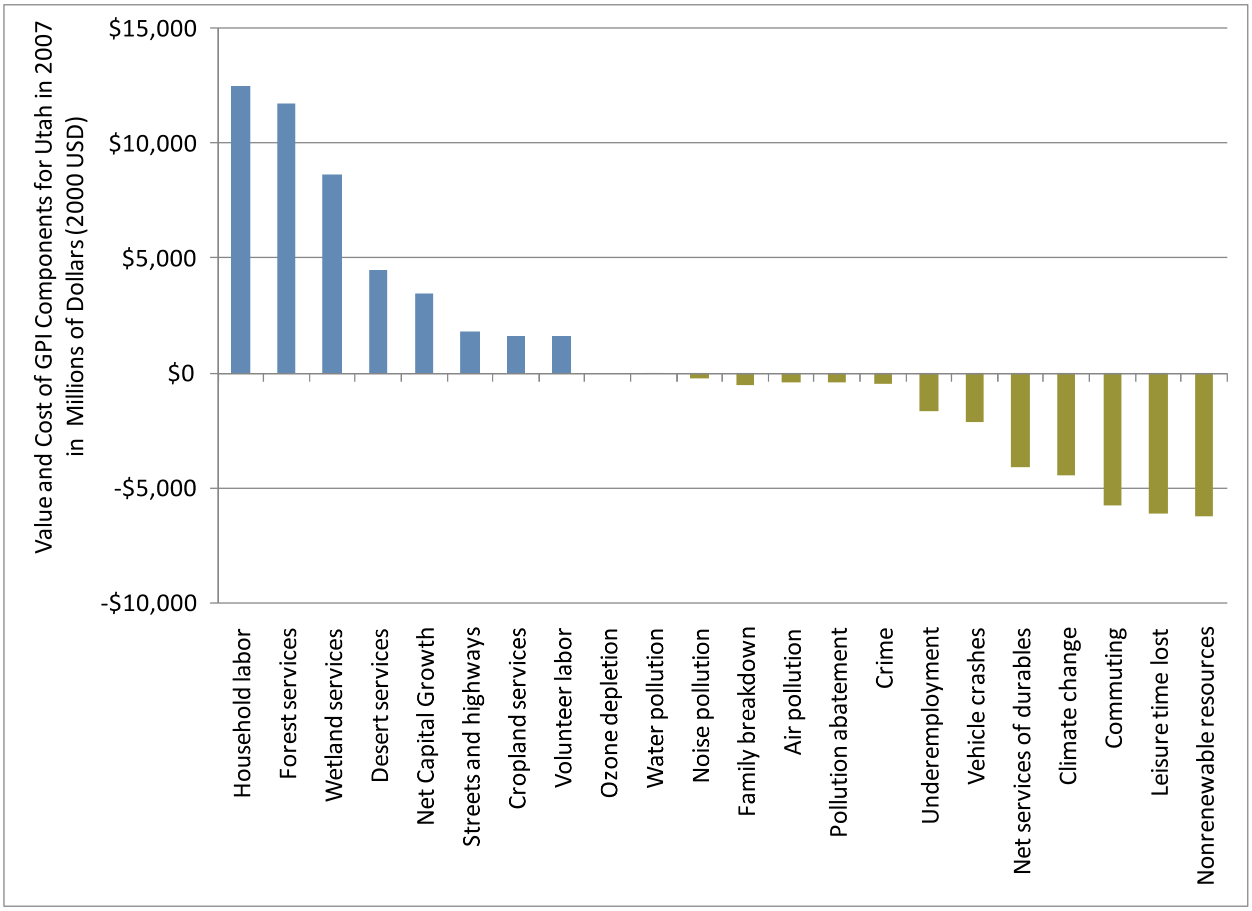
The GPI study is a contribution to the Utah Vital Signs project of the Utah Population and Environment Coalition (UPEC). The project aims "to empower Utah citizens and key decision makers to make better decisions about their future by providing clear, well-documented information about key indicators of environmental sustainability in Utah." Currently, there is no metric available to Utahns to easily compare the tradeoffs between social, economic, and environmental factors that affect Utah's communities. The GPI is consistent with the project's goal of bringing greater clarity about policy choices and their impact on the social, economic, and ecological systems that support our quality of life in Utah.

THE GPI METHODOLOGY

The GPI methodologies were initially developed for national-level assessments. However, interest is growing in applying GPI methods at local and regional scales due to the impact that local policies can have on quality of life. In spite of data availability and quality challenges associated with applying GPI at local scales, GPI studies in the US have been completed in Vermont, Ohio, Minnesota, the San Francisco Bay Area, and Maryland. In addition to Utah, there are efforts in progress in Michigan and Massachusetts to complete state-level GPI studies. To our knowledge, the Utah GPI study is the first state-level GPI study in the intermountain west.

The GPI methodology uses personal consumption as the starting point for the analysis, to which 24 different adjustments are made, which together constitute the GPI accounts. Personal consumption expenditures include all types of spending by households to enhance their material well-being. This starting point assumes that consumption represents an individual's ability to improve their own well-being. The first adjustment is for income distribution, which corrects for the overstated consumption levels (material welfare) associated with income inequality. The adjustment may also be interpreted as an estimate of the loss of potential output for society or erosion of social cohesion due to inequality.

The value of positive non-market benefits (e.g., unpaid household work, volunteer work, and services provided by ecosystems) is added to the metric. Losses associated with economic activities that undermine quality of life (e.g., cost of crime, family breakdown/divorce, loss of leisure time, and cost of unemployment and underemployment) and that entail the loss of natural capital in the state (depletion of non-renewable resources, long-term environmental damage, and cost of air pollution) are subtracted from the measure.

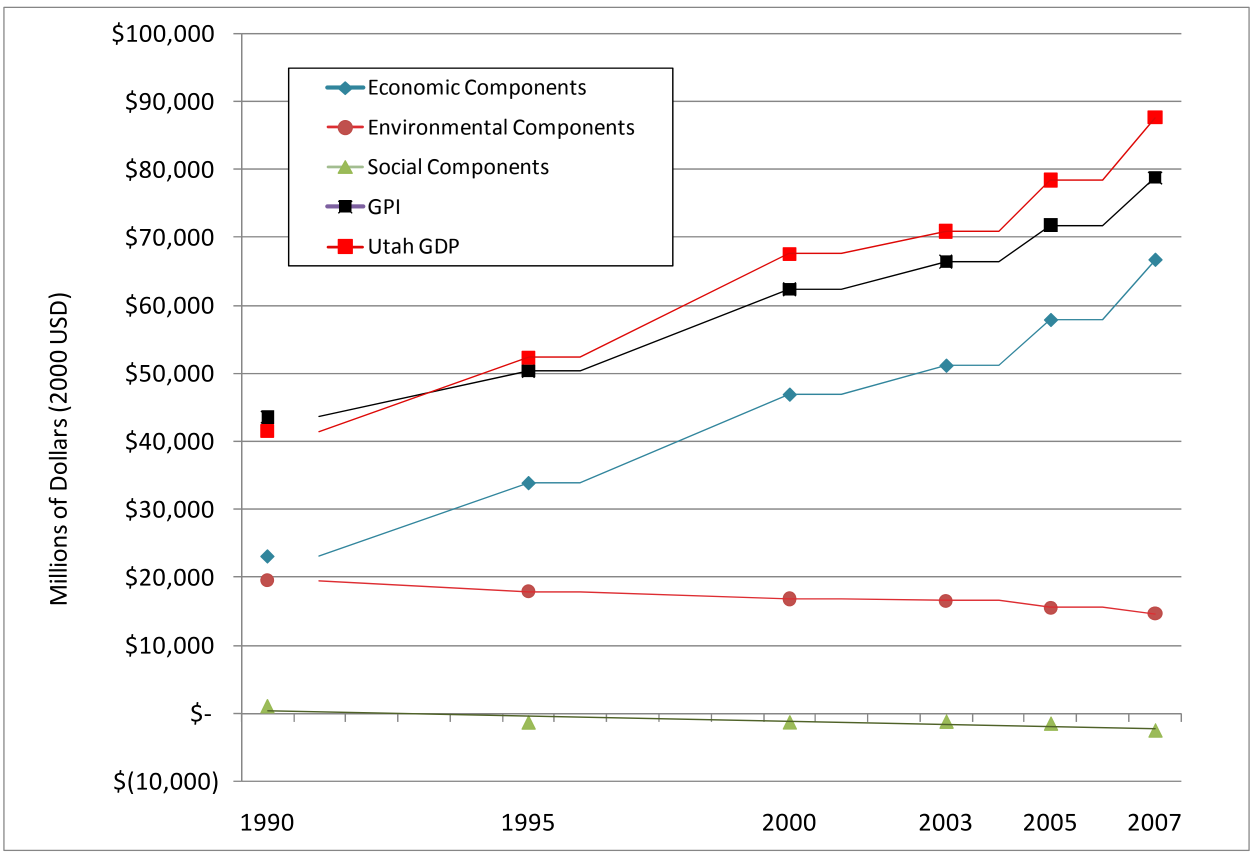


The Utah GPI study focuses on trends since 1990, which is the first year with historically reasonably good local data availability for many of the components. We have calculated the GPI at five-year intervals (1990, 1995, 2000, and 2005). We also included a GPI calculation for 2003, to match the results from the Utah Ecological Footprint study, and 2007, which represented the most recent year for data availability when we began the study in mid-2009. The Utah GPI study includes a state-level calculation as well as county-level estimates of GPI for the state's six most populous counties: Cache, Davis, Salt Lake, Utah, Washington, and Weber. The Utah GPI is reported in 2000 US dollars.

UTAH HAS MADE GENUINE PROGRESS SINCE 1990

Between 1990 and 2007, the Utah's GPI increased, albeit at a slower rate than the GDP for Utah, which suggests that the state's GDP overstates the improvement in the well-being of Utahns. The starting point of GPI is personal consumption expenditures, which also is the largest component of GDP. However, beyond this, the GPI estimation includes a number of contributors to our well-being that are unrecognized by the GDP. Top contributors among these are unpaid household labor and the services provided by forests, wetlands, and deserts. Utahns' quality of life is reduced, on the other hand, by a number of costs that are also not accounted for in the GDP. Chief among these are the cost of depletion of the state's nonrenewable resources, lost leisure time, and cost of commuting.

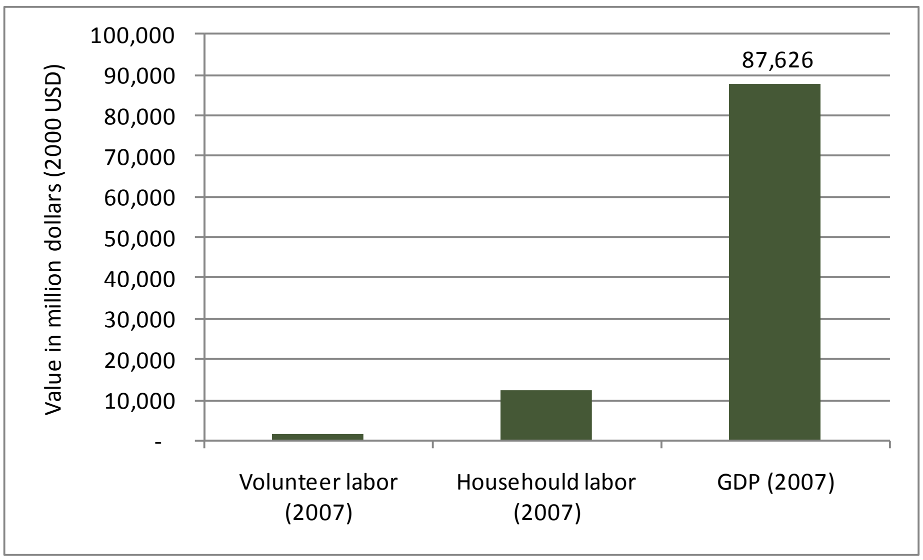
In general, the economic components of GPI—chief among them personal consumption and net capital growth—were on the rise between 1990 and 2007. However, the value of both environmental and social components of GPI declined during the same period, offsetting part of the gain in the economic components.



VOLUNTEER AND HOUSEHOLD LABOR HAVE REAL VALUE FOR UTAH

Two major contributors to Utahns' quality of life are housework and volunteer work, neither of which is counted in the GDP because the work is unpaid.

Volunteer labor is unpaid labor that is important for supplementing services provisioned through the market. Volunteer labor also builds and strengthens social ties in a community. On average, Utahns volunteered 2.3 times the national volunteer hours between 2002 and 2008. This performance ranks Utah the first in the nation in terms of volunteer work. The value of volunteer labor in Utah in 2007 was $1.6 billion dollars, more than twice the value of $690 million in the state in 1990.



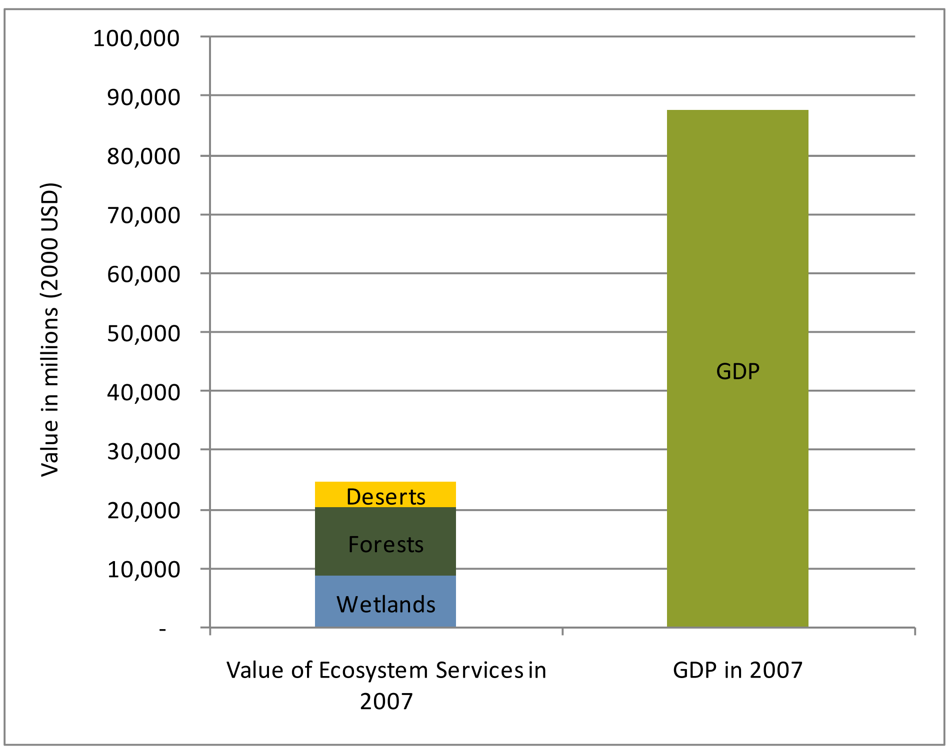
In 2007, the total monetary value of household labor performed in the state totaled $12.5 billion, up from $9.5 billion in 1990. To give an indication of the relative magnitude of the total monetary value of this unpaid set of activities we note that this sum amounted to 14 percent of Utah's GDP in 2007. Thus what is unnoticed in the GDP amounts to a substantial contribution to the well-being of Utahns. Consistent with the national trends, however, the amount of time the average Utahn spent on housework and care work declined. This decline largely reflects substitution of store-bought goods and market services for the unpaid services previously provided by family members as these market substitutes become more widely available and affordable. These changes indicate a shift in the locus of work from the household to the market and thus would be reflected as increase in personal consumption expenditures. That said, in 2007, in Utah women and men who were not in the labor force or were unemployed performed approximately 10% more household hours relative to the national average.

ECOSYSTEMS PROVIDED UTAHNS WITH $25 BILLION IN GOODS AND SERVICES IN 2007

Utah's wetlands, forests, and deserts provide valuable services to society, many of which are not valued in state (or national) income accounting. Ecosystem services are described in terms of provisioning services, regulating services, and cultural services. Provisioning and cultural services—also described as direct uses of ecosystems—include consumptive uses of food, timber, fiber, fuel, and medicinal products that are generally counted in the GDP. Nonconsumptive uses include cultural services such as recreation, aesthetics, heritage value, bird watching, and spiritual and social values that do not require harvesting products. Regulating services include water filtration, dust regulation (by plants that stabilize soils and reduce erosion), flood protection functions of wetlands, gas regulation (e.g., carbon sequestration and production of oxygen), processing of nutrients, and waste absorption and detoxification by wetlands, forests, and other ecosystems. For example, a forest provides a recurring flow of timber, erosion control, biogeochemical cycling, and clean water.

Environmental degradation and the losses of wetland, forest, and arid land ecosystems in Utah result in losses of these services that have real costs in terms of damage costs (e.g., loss of protection services), replacement cost (e.g., the need to replace water filtration capacity of forest systems with more highly engineered treatment systems and chemical treatment), and direct losses of commodities (e.g., productivity of agricultural land and rangeland or supply of timber from forests or fish from fresh waters). In some cases, values of these ecosystem services can only be estimated by asking people directly what they are willing to pay to preserve an ecosystem (i.e., willingness to pay or contingent valuation methods). All of these valuation methodologies (willingness to pay, replacement costs, and direct losses of commodities) are included in the valuation of Utah's wetlands, forests, and grasslands for this GPI study.

Wetlands are relatively rare in arid Utah, making wetland acreage even more valuable. Wetlands around the Great Salt Lake make up the majority of wetland acreage in the state and provide critical habitat for migratory bird species. Marshy meadows in the mountainous areas of Utah also perform an important regulatory function for water supply and water quality. The value of services provided by wetlands to Utahns in 2007 amounted to $8.6 billion. Utah forests provide the structure for diverse ecosystems and serve as important habitat for migratory songbirds and raptors, bats, and other wildlife. In addition, forests provide soil erosion control that protects pristine mountain streams and are heavily used for recreation. They also provide some timber and range for cattle. The total value of forest ecosystem services calculated for use in the GPI was $11.7 billion in 2007. Utah's desert grasslands and scrubland provide ecosystem goods and services to Utahns primarily through soil erosion control (dust regulation), recreation (hiking, camping, off-road vehicles, etc.), commodities (range for cattle), and habitat for wildlife. Near urban areas, on public lands, and on sites culturally valued by Native Americans, aesthetic, recreational, and cultural values for deserts are also large. In addition, deserts play an important role in oxidation of atmospheric methane, an important greenhouse gas. Finally, providing habitat for pollinators may be one of the greatest services that deserts and scrublands provide. Many Utah crops rely on this pollination including orchards and alfalfa. The total value of desert grasslands and scrublands was $4.5 billion in 2007.



LOSS OF PRIME FARMLAND REPRESENTS A SIGNIFICANT COST TO UTAH'S FUTURE

Agriculture has been an integral component of the Utah landscape at least since settlement by Mormon pioneers. Prime farmland is relatively scarce in the state. Today, the most common agricultural commodities grown in Utah are dairy, cattle, hay, hogs, and greenhouse products, with the majority of farms having less than 100 acres. The majority of cultivated crops are grown in valleys fed by mountain runoff.

In 2007, Utah had 1.8 million acres of cropped farmland, a reduction of 10% since 1987. This trend is relatively consistent across the state's most populous counties with the sharpest recent decline in Davis County and an increase in Washington County. The loss is primarily due to the expansion of commercial and residential developments, and represents a semi-permanent loss of prime farmland in many of Utah's most productive valleys. Utah will thus face not only reduced income from farmlands but also loss of the security of being able to grow food locally and sustainably in the future.

In this study, option values were used to estimate the value of food security for prime farmland in Utah. Option value is the value of preserving the option to use something in the future (e.g., preserving prime farmland for future use, even if the land is not currently being actively used for food production). The option value of these lands was valued at $436 to $1,910 dollars per acre per year (in 2000 USD) over and above the value of agricultural products produced from the land. In 2007, the cropland in Utah had an estimated option value of $1.6 billion (this excludes the value of crops grown, which are captured in the personal consumption component of GPI).

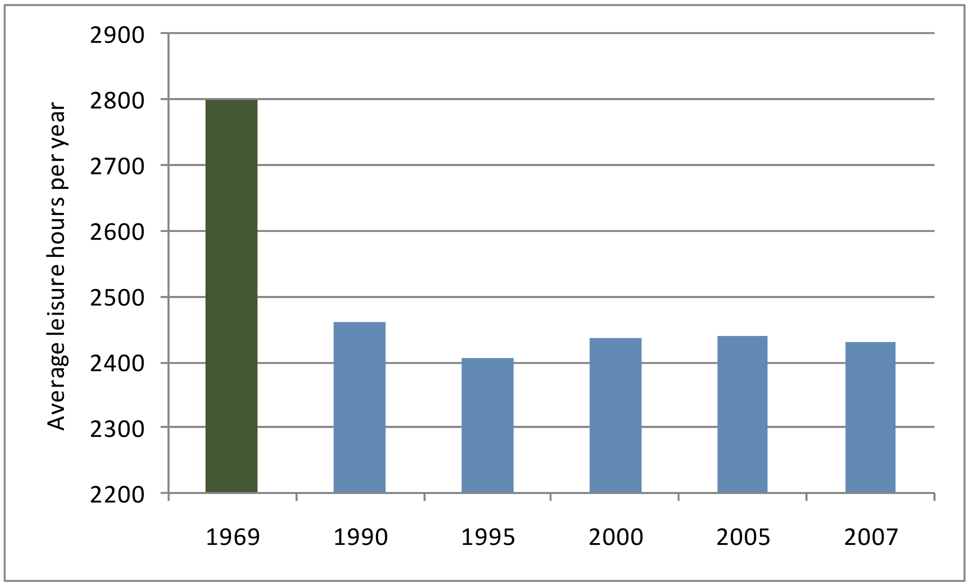
UTAHNS EXPERIENCED RISE IN BOTH OVERWORK AND UNDEREMPLOYMENT

By focusing only on market transactions GDP fails to account for the contributions of free time to our well-being. Thus the time-use patterns, such as overwork and decline in leisure, that underlie our increased personal consumption expenditures are unaccounted for in the GDP.

Overwork and underemployment increasingly coexist in the U.S., and Utah is no exception. Utah workers who were employed full-time worked a modest amount more annually in 2007 than in 1990 (2,263 hours in 1990 v. 2,297 in 2007). At the same time, there was an increase in the number of workers who are considered underemployed—those who are employed part-time but would like to work full-time.

Underemployment and long-term unemployment undermine quality of life because they contribute to social exclusion, undermine cohesion of communities, and contribute to frustrations that may lead to a variety of social problems. The period covered by the study was one of low unemployment and underemployment rates, nationally and in Utah. Utah had even lower unemployment rates than the nation as a whole. Compared to full-time, full-year workers, the underemployed workers provide far fewer hours in the labor market. These "unprovided" hours of the underemployed in Utah increased between 1990 and 2007. The cost to society of underemployment and unemployment peaked at $2.1 billion in 2003 and stood at $1.7 billion in 2007.

While the underemployed enjoy "forced" leisure, the fully-employed workers experience rise in overwork that is also captured by the loss of leisure time for this group. When hours performed in the labor market are combined with unpaid household labor hours, the fully-employed workers in Utah performed between 3,014 and 3,069 hours of work per year during the study period. Assuming a total of 5,475 hours available for work and play in a given year, this implies Utah's fully employed workers had 2,400 to 2,460 hours of leisure per year during the study period. Compared to the peak leisure hours experienced by the average fully-employed worker in the US in 1969 (2,800), the fully-employed worker in Utah had 339 hours less leisure time in 1990 and this leisure gap widened over the study period to 369 hours. The estimated cost of lost leisure hours nearly doubled from $3.2 billion to $6 billion between 1990 and 2007.



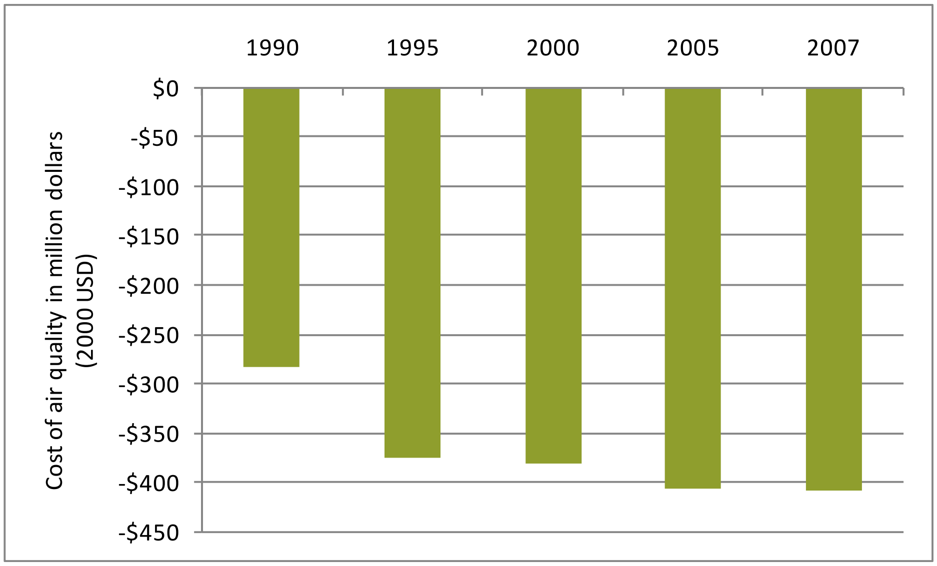
UTAH HAS MADE PROGRESS IN REDUCING POLLUTION: MORE IS NEEDED TO COMPENSATE FOR POPULATION GROWTH

Utah has made progress in reducing water pollution and air pollution, but the increasing population in Utah threatens these gains and requires renewed efforts to continue to reduce our individual, municipal, and industrial contributions to pollution. More people in our communities represent a greater potential for pollution emissions but also mean that more people are impacted by poor air and water quality. The one form of pollution that has continued to increase across the state is noise pollution, especially in urbanized areas of the state.

Clean water in Utah's streams, lakes, and rivers provides clean drinking water, healthy fisheries, safe and enjoyable recreation, aesthetics, increased property values and healthy aquatic life. Polluted water results in many costs including increased costs of treating drinking water, losses to tourism and recreation revenue, costs associated with the loss of fisheries, reduced property values and the loss of aquatic life and habitats that depend on clean water. Since 1972, the quality of fresh waters in the US and Utah has improved in large part due to the widespread implementation of secondary and tertiary wastewater treatment systems, as required under the Clean Water Act. Between 1990 and 2007 the estimated total costs associated with water quality impairments in Utah have fluctuated between $3.2 million and $4.9 million.

Air quality impacts society most directly through human health. Poor air quality has been linked to decreases in lung function, increases in heart attacks, and increases in the severity and frequency of asthma. Other costs associated with air pollution include loss of visibility associated with haze and particulate matter. Air quality in Utah is of greatest concern in valley areas that experience temperature inversions associated with topography.

During inversions, the Wasatch Front and Cache Valley often record the worst air quality in the country. Despite the challenges associated with topography, Utah has significantly cleaner air today compared to monitored concentrations in the 1980s. Reductions in emissions since then, primarily in motor vehicle and industrial emissions, have resulted in improved air quality and visibility throughout the state. Nonetheless, counties along the Wasatch Front have not been able to attain National Ambient Air Quality Standards (NAAQS) established by the EPA and regulated by the Utah Department of Environmental Quality. Total cost of damages associated with air quality in the state increased from $210 million in 1990 to $409 million in 2007. Salt Lake County accounts for nearly half of the statewide damage costs, in large part due to the topography and population affected in the area. This is a conservative estimate of the costs of air quality that only partially accounts for Utah's unique topography and does not account for any reduced economic development opportunities associated with companies choosing to relocate in other cities due to poor air quality in Utah's metropolitan areas.

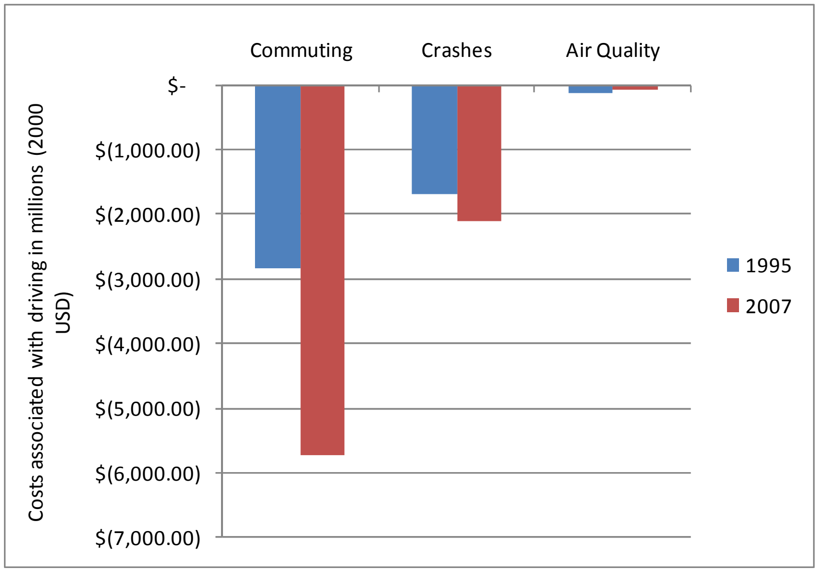


Noise pollution disrupts sleep, recreation, and general well-being. Loud and repeated noises often are the most disturbing. Not only does noise impact the enjoyment associated with our environments but also it can undermine human health. The total cost of noise pollution in Utah increased steadily from $162 million in 1990 to $209 million in 2007 as a result of the urbanization experienced around the state. The largest costs of noise pollution are found in Salt Lake County, the most urbanized county in the state.

It costs us to dispose of our waste or to reduce the pollution we create. Three costs enter the daily lives of most Utahns: We pay for automobile emissions abatement, wastewater treatment (municipal sewage and septic), and solid waste (garbage) disposal. We refer to these as household pollution abatement costs. Since 1990, the amount of municipal garbage Utahns generated has risen steadily with population growth and increased personal consumption. The amount of garbage generated per person rose in the 1990s and peaked in 2003. The total cost of household pollution abatement increased from $268 million in 1990 to $411 million in 2007. The majority of the cost is associated with wastewater treatment, followed by solid waste disposal, and auto emissions abatement.

SOCIAL AND ENVIRONMENTAL COSTS ASSOCIATED WITH DRIVING ARE SUBSTANTIAL AND RISING

Commuting costs include the expense of owning and operating a vehicle, loss of time available for other activities, and public transit expenditures. The commute time per commuter in Utah increased from 158 hours in 1990 to 178 hours in 2007. The expense and time cost of driving for Utahns was $5.8 billion in 2007, up from $2.8 billion dollars in 1990. In addition to these commuting costs, driving also carries the risk of accidents and contributes to air pollution. In 2007, vehicle crashes in Utah cost $2.1 billion in terms of property damage and healthcare expenses as well as the value of lost life and lost wages associated with injury and death. In addition, emissions of air pollutants from cars accounted for $69 million of air quality costs in Utah in 2007 (a reduction in costs associated with mobile sources since 1990). Thus the total cost of driving in Utah in terms of commuting, vehicle accidents, and reduced air quality was $7.9 billion in 2007, more than double the cost of driving in 1990 of $3.2 billion.



UTAH HAS MADE GOOD PROGRESS TOWARDS REDUCING CRIME, DIVORCE, AND AUTOMOBILE ACCIDENTS

The cost of crime is borne by potential or actual victims of crime, by government in the form of police services and by businesses through hiring of security guards. The peak year for incidents for most types of crime in Utah was 1995, after which the crime rates and the per capita cost of crime decreased. While the direct cost of crime constitutes the larger component of the total cost of crime, defensive (indirect) expenditures by households to prevent the erosion of safety rose faster than the direct cost of crime over the 1990–2007 period.

Divorce has negative costs to individuals associated with legal fees, setting up separate households, and impacts to children affected by divorce. While the total number of divorces in Utah increased until 2005, the divorce rate (divorces per 1000 people) steadily declined since 1990. Divorce cost Utahns $234 million in 2007, down from $258 million in 1990.

There has been a steady decline in crashes in Utah resulting in injury or death since 1970 due to traffic safety programs, seatbelt usage, aggressive media and enforcement programs targeting driver behavior, improved roadways, improved vehicle safety, and advancements in emergency response. Utah’s traffic fatality rate has been lower than the U.S. rate since 2001. Nonetheless, total vehicle crashes in Utah reached a low of 50,389 in 2003 and increased since then to 61,245 crashes in 2007. While the total costs associated with vehicle crashes in Utah rose from $1.7 billion in 1990 to $2.1 billion in 2007, the per capita cost in Utah decreased steadily from $971 in 1995 to $782 in 2007, reflecting the reduced crash rate (crashes per 1000 people).

PERMANENT DEPLETION OF NONREWABLE RESOURCES IS A SIGNIFICANT LOSS OF WEALTH TO UTAHNS

GPI includes an estimate for the depletion of natural capital in order to assess the sustainability of income and consumption levels in the future. The depletion of nonrenewable resources in Utah such as coal, natural gas, and oil results in a net loss of wealth to Utah and is a source of income that cannot be sustained into the future. This loss of wealth is measured as the cost to replace these resources with renewable energy sources. While the present levels of resource extraction can be sustained for some time, without depletion or sharp rise in resource prices, in the replacement cost approach the actual cost of establishing a renewable resource substitute is attributed to the point in time when the depletion takes place. We included only those depletions associated with consumption by Utahns in our calculation because personal consumption is our starting point and deducing the loss of resources consumed by energy customers outside of Utah would be an overestimate of the impact on Utahns today. The permanent loss of natural resources is the largest deduction for Utah's GPI and amounted to $6.2 billion in 2007. This is a conservative estimate as it does not include the loss of minerals, metals, and other nonrenewable natural resource losses.

CONCLUSIONS AND IMPLICATIONS

The Utah GPI study shows that Utahns experienced improvements in quality of life in the 1990-2007 period. The aggregate Utah GPI increased since 1990. However, the growth rate was slower than the state's GDP, which indicates that the state GDP overstates the improvement in the well-being of Utahns. While the economic components of GPI were on the rise, driven upward by personal consumption expenditures, societal and environmental components trended downward. Underlying these trends are the increasing costs and decreasing values associated with social and environmental components that contribute to our quality of life. The study shows that social and environmental factors affecting quality of life might require attention and investment.

The study demonstrates that tools can be developed and used to provide a more useful measure of progress in a state than the GDP. Social and environmental factors can be combined with economic factors in an integrated and transparent framework to arrive at an assessment of general progress and quality of life in Utah. This framework can be used to provide a snapshot of quality of life in a given year and to track its various dimensions over time in monetary as well as physical (nonmonetary) terms. The GPI accounts can be adopted by the state government and/or other public or private institutions so as to track actual progress for Utahns at the state and county level. The state government is best suited to maintain indicators such as the GPI, given the data-intensive nature of the measure. Various government agencies, coordinated by one department, such as the Governor's Office of Planning and Budget, could best provide the information in their respective areas of expertise to undertake annual updates for inclusion in the GPI. A web-based tool similar to the one used by the State of Maryland (State of Maryland 2010) could be developed to report changes in the GPI and its components to Utahns.

In addition, this transparent and integrated framework can be used to guide budget and planning in the state and its counties, allowing decision-makers to examine the trade-offs in using resources and assessing well-being outcomes of policy. Furthermore, GPI accounts can be aligned with existing state government performance assessment tools to estimate the quality of life impacts of public policy or budgetary decisions. While many of these impacts may not be discernible for a number of years, by insisting on full accounting of the benefits and costs the GPI framework provides a suitable tool for assessing the full and long-term impacts of public policy and budget decisions.

INTRODUCTION

UTAH VITAL SIGNS: TRACKING PROGRESS TOWARD SUSTAINABILITY AND QUALITY OF LIFE

The Utah Genuine Progress Indicator (GPI) study is a contribution to the Utah Vital Signs project of the Utah Population and Environment Coalition (UPEC). The Utah Vital Signs project aims "to empower Utah citizens and key decision makers to make better decisions about their future by providing clear, well-documented information about key indicators of environmental sustainability in Utah." The project was initiated in 2006 in response to the observation that data are plentiful but are not compiled and summarized in a format that give an integrated understanding of social progress and environmental quality in Utah. The premise of the project is that in order to make the best decisions for our future, we need clarity about our choices and their impact on the social, economic, and ecological systems that support our quality of life.

The first study completed under the Utah Vital Signs umbrella was the Ecological Footprint study, which estimated how well Utah is sustaining its unique natural heritage and preserving it for future generations (McIntyre et al. 2007). The footprint study was completed in June 2007 and provides a strong metric of Utah's consumption patterns in comparison to the rate of natural resource production in the state, in other words, the sustainability of Utahns' consumption. The results indicate that Utah is currently living beyond its ecological means. Between 1990 and 2003, Utah went from an ecological surplus (our lands produced more goods than we consumed) to an ecological deficit (Utahns are consuming more than our lands produce) (McIntyre et al. 2007).

Standard measures of economic progress are closely correlated with our Ecological Footprint. The gross domestic product (GDP) for Utah indicates steady economic growth from 1997 to 2007 in inflation-adjusted terms in both total value (9% increase per year) and per capita (a 4% increase per year) terms. Earlier data show continuous economic growth in Utah going back to 1963 (real GDP increased by 15% a year on average between 1963 and 1997).[1] However, there has been a longstanding concern among economists and policy makers about the adequacy of GDP as a measure of economic performance and a broader concern about the relevance of GDP to measure societal welfare.

The results of the Ecological Footprint study raise the question of whether Utah has benefited from the over-consumption of natural resources. Has economic growth in Utah led to genuine social, economic, and ecological progress in the state in the past 20 years? The GPI, the second study of the Utah Vital Signs project, aims to answer this question. The GPI is an objective quality of life metric, which measures progress through consumption activity that is adjusted for income distribution. A host of other adjustments follow, including adding the value of non-market work and services provided by natural ecosystems, deducting the monetary costs associated with activities such as commuting, automobile accidents, crime, and the depreciation of natural capital through processes such as pollution, natural resource depletion.

Quality of life measures provide a tool for the public and decision makers to relate the message from ecological indicators, such as the Ecological Footprint, to direct impacts on people and communities. GPI meets UPEC's criteria for selecting indicators for Utah. Accordingly, an indicator should 1) assess impacts of growth; 2) adopt a

[1] In 1997, the Bureau of Economic Analysis adopted the North American Industry Classification System (NAICS), switching from Standard Industrial Classification (SIC), which resulted in a discontinuity in the GDP-by-state time series in 1997 and made the 1963–1997 data series not strictly comparable to the post-1997 data.

process-focused approach; 3) rely on appropriate geographical boundaries; 4) make use of existing data sources; 5) tie in with national/international metrics; and 6) focus on indicators related to people, land, water, air, and energy. The GPI was selected for Utah because it relies on readily available economic, ecological, and social data; it has been estimated for other states and nations; it is measured in dollars, an easily understood metric; and it is based on a methodology that is already developed and available. The changes in GPI can be tracked over time, both as an aggregate, single-number indicator, and in terms of each of its components.

PROJECT GOALS AND OBJECTIVES

The primary goal of the GPI study is to answer the following question: *Has economic growth in Utah led to genuine social, economic, and ecological progress in the past 20 years?* The specific objectives of the GPI study are as follows:

- Provide Utah decision makers with an alternative metric to GDP, in monetary units, to assess progress toward sustainability and quality of life;
- Quantify explicitly, in monetary units, the cost and value of ecological, social, and economic characteristics of Utah to our quality of life;
- Assess whether the quality of life in Utah is improving;
- Compare recent GPI values and trends over time for specific counties within Utah;
- Identify the largest opportunities to improve well-being for Utahns; and
- Integrate the results of the GPI study with the results of the Ecological Footprint study.

ORGANIZATION AND RESEARCH TEAM

UTAH POPULATION AND ENVIRONMENT COALITION (UPEC)

The UPEC is a program component of the Wellness, Health, and Lifestyle Education (WHALE) Center, which is a nonprofit organization. Since 1997, UPEC has addressed the ongoing concerns of population increase and resource consumption in Utah, particularly along the Wasatch Front. The UPEC mission statement declares “We believe it is our responsibility as citizens of the earth to be concerned about the environment, sustainability, and population. Furthermore, we place special value on the unique heritage and landscape of the state of Utah” (UPEC 2010).

UPEC’s goals are as follows:

- To provide educational and research services to further understanding and cooperation regarding environmental and population issues, and to promote the concept of sustainability for individuals, organizations, and communities in Utah.
- To operate on a non-profit, non-partisan basis for the promotion of the social welfare by working
    - for the encouragement of programs that promote healthy environmental, sustainability, and population practices and policy;
    - for the facilitation of communication between individuals and organizations in Utah regarding environment, sustainability, and population issues;
    - to advance and develop a network and/or constituency for population, sustainability, and environment issues within the state of Utah; and
    - to provide educational resources for schools, churches, and other interested organizations on population, sustainability, and environment issues.

In summer 2006, several individuals within UPEC wrote a proposal for an initial pilot round of a Utah Vital Signs study. Private funding was secured for the Ecological Footprint study; the UPEC Board and the leadership of WHALE approved the project. Work on the Ecological Footprint study commenced in October 2006 and was completed in June 2007. In summer 2008, UPEC began looking for additional indicators for the Utah Vital Signs project. Private funding was secured for the GPI study, which the UPEC Board approved in October 2008. Work commenced on the project in earnest in April 2009.

RESEARCH TEAM

The board contracted with Erica Gaddis to serve as project director and with Günseli Berik, Kenneth Bagstad, and John Lowry to provide specific expertise and contributions to the project. Gaddis focused primarily on the ecological components of the GPI, and Berik focused primarily on the social and economic components of the GPI. Bagstad has completed two other local GPI studies: one for Ohio and one for the Northern Forest region of New England. He provided data sources, clarification on local-level GPI methodology, as well as recommendations for modifications to the Utah GPI study. Lowry completed the spatial analyses for the project, with a focus primarily on land-use change. Together, Gaddis and Berik drafted the GPI report. For more information about this research, please contact the research team:

- Erica Gaddis, Water Resources Scientist, SWCA Environmental Consultants, egaddis@swca.com
- Günseli Berik, Professor, Department of Economics, University of Utah, berik@economics.utah.edu
- Kenneth Bagstad, Postdoctoral Associate, Gund Institute for Ecological Economics, University of Vermont, kbagstad@uvm.edu
- John Lowry, formerly Associate Director, GIS Laboratory, College of Natural Resources, Utah State University; currently at the University of the South Pacific, Fiji, lowry_j@usp.ac.fj

TECHNICAL ADVISORY COMMITTEE

A technical advisory committee, including the researchers described in the previous section, was formed at the beginning of this project. The committee provided guidance on the scope of the study, discussed methodological concerns, and provided feedback to Gaddis and Berik, reviewed the initial GPI results and report, and provided context for discussing the results of the study. Members of the technical advisory committee are listed below.

Name	Expertise	Affiliation
Kenneth Bagstad	Ecological economics	Gund Institute for Ecological Economics, University of Vermont
John Bennett	Planning	Quality Growth Commission
Günseli Berik	Economics	Department of Economics, University of Utah
Erica Gaddis	Natural resources	SWCA Environmental Consultants
John Lowry	Spatial analyses	University of the South Pacific (formerly Utah State University)
Wayne Martinson	Utah Vital Signs, sustainability indicators	Chair, UPEC
Sandra McIntyre	Ecological footprint	UPEC
Helen Peters	Transportation planning	InterPlan

BACKGROUND AND THEORY

DEFINING PROGRESS

Most economic policy is implemented to achieve economic growth, as measured by the Gross Domestic Product (GDP). This is based on the assumption that welfare is very closely correlated with economic growth. GDP is a tally of all monetary exchanges taking place in a given year. It does not differentiate between economic activities that add to our well-being and ones that undermine our quality of life. GDP includes market exchanges related to undesirable activities, such as crime, poor health, war, and pollution, even though they are not "welfare-enhancing." For example, cleanup activities after an oil spill add to the GDP. While such activities create jobs they invariably do not compensate for the long-term loss of jobs in the fishing and tourism industries or for the ecological damage. Yet such spills add to the growth of the GDP. Conversely, GDP excludes many activities that do enhance welfare but occur outside of markets, such as household labor, volunteer activities, and ecosystem goods and services (Daly and Cobb 1989).

GDP per capita is also a poor indicator of material well-being because it does not account for the distribution of income among the population. Where moderate to high inequality exists, the average person's share of the GDP overstates the income share of those in the low-end of the income distribution and understates the income of those in high-income groups.

The income concept underlying GDP is devoid of considerations of sustainability (Lawn 2003). First, GDP does not include depreciation of built capital used to generate the current income; hence, the income measured is not sustainable income. Secondly, as noted above, GDP does not consider whether production and consumption involve ecologically unsustainable activities. There are a host of disservices or negative externalities generated by economic activities. Third, GDP treats all spending as income, even when some of these expenditures are made to protect citizens from the side effects of past and present economic activities. These are regrettable *defensive expenditures* that do not add to welfare, but prevent its deterioration, that is "those expenditures that we have to make to protect ourselves from the unwanted consequences of the production and consumption of other goods by other people" (Daly and Farley 2004). These expenditures should generally not count toward the welfare of individuals because they are really correcting a negative impact rather than producing a positive benefit in their own right. Examples of defensive expenditures include building thick walls to block out noise pollution, using air filters to reduce the impacts of air pollution, or purchasing guns for protection.

In addition, GDP does not count the value of services provided to society by the environment, which can also be referred to as natural capital (an extension of the concept of capital to the wider natural environment). Natural capital is the "stock" of ecosystems that produce a flow of goods and services that are consumed by humans. The problems in using the GDP to track human welfare and the potential solutions to these problems have been explained in detail in the recent study by the Commission on the Measurement of Economic Performance and Social Progress (2009), also known as the Stiglitz Commission after its chair, the Nobel laureate Joseph Stiglitz. The Commission included among its recommendations both adjustments to GDP and the development and use of better measures of quality of life. Among the latter is the recommendation to track well-being in its multiple dimensions.[2]

[2] See Gertner (2010) for a summary discussion of the logical flaws and limitations of the GDP and the recent proposals to address these problems.

There are two general approaches for measuring quality of life in a community, which are typically divided into subjective and objective measures of well-being, with GDP often serving as the short-hand indicator of choice as an objective measure. The search for an adequate measure has resulted in several different indexes for quality of life (Hagerty et al. 2001). Subjective measures are based on self-reported levels of happiness or life satisfaction, which are compiled through survey data of a given population. The objective measures are based on community-level data, typically available at the state and national level, to measure the *opportunity* for a greater quality of life. The latter methodology does not incorporate individual-level reports of quality of life. The objective measures, including GPI, are generally more appropriate in assessing trends and comparing between communities. Such quality of life measures include the Measure of Economic Welfare (MEW) developed by William Nordhaus and James Tobin (1972), the Index of Sustainable Economic Welfare (ISEW) by Daly and Cobb (1989), the Human Development Index (HDI) of UNDP (1990), and the GPI, which is the recent variant of ISEW (Cobb et al. 1995; Anielski and Rowe 1999). MEW, ISEW, HDI, and GPI are all defined in reference to the GDP or its components. The HDI includes GDP per capita as one of its three components, whereas MEW, ISEW, and GPI include a component of GDP (personal consumption) as their starting point for making adjustments to address the shortcomings of the GDP. This approach recognizes the central importance of an economic starting point as an indicator of opportunities to live well and also the relative ease of using a single number to track changes in quality of life. GPI, along with the earlier MEW and ISEW, offer the additional advantage in that the aggregate indicator is easily decomposable into constituent parts that allow tracking progress on the economic, social, and environmental fronts. In turn, the status in each component can help policy intervention. As such, GPI is stronger than other indicator suites that track progress on economic, social, and environmental fronts but have no good way to aggregate results.

THEORETICAL UNDERPINNINGS OF GPI

Beginning in the 1970s, some economists began to challenge the assumption that economic growth is necessarily tied to improvements in human welfare. The field of ecological economics, a relatively new discipline, emphasizes goals of achieving optimal scale, fair distribution, and efficient allocation of resources rather than simple economic growth (Daly and Farley 2004). Prioritizing human welfare rather than economic growth requires alternative metrics of human welfare in order to measure our progress and compare policy alternatives.

In the 1970s, Nordhaus and Tobin developed MEW, a direct index of welfare that corrected for defensive expenditures as well as income distribution. This index tracked closely with the United States (U.S.) gross national product (GNP) between 1929 and 1965, which validated the use of GDP for that period as a metric of human welfare. In the late 1980s, Herman Daly and Clifford Cobb developed ISEW, which incorporated many of the factors included in the MEW but also corrected for environmental costs (Daly and Cobb 1989). This metric closely correlated with GNP for most developed countries through the 1970s, a finding that is supported by the original MEW work, after which GNP continued to increase while the ISEW began to stabilize or decline.

In the 1990s, the ISEW was modified by Cliff Cobb, Craig Rixford, Ted Halstead, and Jonathan Rowe and referred to as the GPI (Cobb et al. 1995; Anielski and Rowe 1999). The GPI aims to provide a comprehensive measure of sustainable economic welfare of citizens. It measures the "welfare a nation enjoys at a particular point in time given the impact of past and present activities" (Lawn 2003: 106).

GPI builds on the concept of *welfare-equivalent income* or *psychic income*, first formulated by the economist Irving Fisher (1906), which refers to the welfare households derive from their consumption activities. This definition of income moves the focus away from the goods (income) produced in a given year to the services that these goods provide for the consumers. Accordingly, additions to stock of built (human-made) capital—consumer durables, roads, machinery, factories—should not be counted as income. Further, Lawn (2003) argues that because not all consumption improves the welfare of consumers, and because there are harmful aspects of consumption or the processes underlying their production process, the concept of welfare-equivalent income should be thought of in a net sense. Thus to estimate the net welfare-equivalent income, the GPI includes consumption activities that contribute to welfare but deducts the amount spent on purchasing, maintaining, or replacing durable goods. A number of additions are then made to reflect the welfare-enhancing activities that occur outside the economy, and a series of deductions are made to indicate the welfare-reducing activities associated with consumption activity.

In addition, GPI accounts for valuable services provided by nature to society, many of which are not valued in traditional economic accounting. These include life-supporting services called *ecosystem services.* Ecosystem services are described in terms of provisioning services, regulating services, supporting services, and cultural services (MEA 2005). Provisioning and cultural services have also been described as “direct” uses of ecosystems and include consumptive uses of food, timber, fiber, fuel, and medicinal products. Nonconsumptive uses include cultural services such as recreation, aesthetics, heritage value, bird watching, and spiritual and social values that do not require harvesting products. Indirect regulating and supporting services include water filtration, dust regulation (plants stabilize soils and reduce erosion), and flood protection functions of wetlands, carbon sequestration in forests, gas regulation (e.g., carbon sequestration and production of oxygen), processing of nutrients, and waste absorption and detoxification by wetlands, forests, and other ecosystems. For example, a forest provides a recurring flow of timber, soil stabilization for erosion control and dust regulation, biogeochemical cycling, and clean water. *Option value* is the value of preserving the option to use an ecosystem in the future and may include provisioning, regulating, and cultural services. An example of option value in Utah would be to attach a monetary value to the preservation of prime farmland for future use, even if the land is not currently being actively used for food production (MEA 2005; Daly and Farley 2004).

Environmental degradation and the losses of wetland, forest, and arid land ecosystems in Utah result in losses of services that have real costs either in terms of damage costs (loss of protection services), replacement cost (e.g., the need to replace water filtration capacity of forest systems with more highly engineered treatment systems and chemical treatment), or direct losses of commodities (productivity of agricultural land and rangeland or supply of timber from forests or fish from fresh waters). In some cases, values can only be estimated by asking people directly what they are willing to pay to preserve an ecosystem (i.e., willingness to pay or contingent valuation methods). All of these valuation methodologies (willingness to pay, replacement costs, and direct losses of commodities) are included in the valuation of Utah’s wetlands, forests, and grasslands for this GPI study.

In the *economic* domain, the GPI is based on the principle of nondeclining stock of built and natural capital from which future generations can produce well-being. This principle necessitates the current use of natural and built capital in a manner that does not jeopardize future use of these assets.

In the *environment* domain, the GPI is closely based on the principle of *strong sustainability* (Lawn 2003; Talberth et al. 2007; Baumgärtner and Quaas 2009). This concept means that there is a limit to the extent to which built capital stocks can substitute for depleted natural stocks. The implication is that a sustainable economic system is one that requires nondeclining stocks of natural capital, and that large increases in built capital stocks cannot compensate for the declines in natural capital. In other words, complementarity of natural capital and built capital implies that neither should be declining. Thus, to keep the stock of natural capital intact, the cost of natural resource depletion must be independently factored into the calculation of human welfare.

The second principle in the environment domain is the principle of resource efficiency, which implies that natural resources, including energy and materials, must be used efficiently to prevent irretrievable losses of natural capital and associated impacts to society from resource limits (Talberth et al. 2007). Thus a sustainable economic system is one that largely emphasizes improvements in the efficient use and quality of physical stocks and flows that underlie the economic processes, rather than unlimited expansion in the scale of the economy, its resource use, and built capital derived from natural resources, as measured by growth of GDP. It should be noted that GPI does not account for environmental degradation in other places associated with production of consumer goods that are imported to a country or a state. Thus, GPI measures closely environmental quality within Utah but not necessarily sustainable consumption. The Ecological Footprint study is a better indicator of sustainability in terms of total consumption by a population (McIntyre et al. 2007).

In the *social* domain, the GPI is based on a notion of social sustainability (i.e., the quality of social life is integral to increasing the welfare of society and must be sustained into the future). Accordingly, the GPI emphasizes the contributions to well-being of the myriad unpaid activities that sustain and build families and communities, and it accounts for the decline in social coherence associated with the decline in distributional equity and underemployment.

GPI is a multi-dimensional index that incorporates trends in social, economic, and environmental components. The advantage of multi-dimensional indexes is that they allow a community to evaluate change overall, rather than solely by detailed individual economic, environmental, or social indicators (Hagerty et al. 2000). These individual indicators—including the components of GPI—are certainly more relevant in tracking down the root source of positive or negative change in a community. There are many examples of specific individual indicators that track change in the economy, education, environment, government, health, housing, population, public safety, recreation, resource use, society, and transportation (see, for example, Sustainable Measures 2010). The GPI does not replace these measures but by offering a single numeric metric adds to the analysis of trends across a variety of issues that are at the heart of community development and progress.

It is important to recognize that GPI is not a direct measure of well-being identified by declarations of individuals in surveys. Rather, it represents the potential for well-being in a community, and in that regard, it is more objective in nature. Measurement of welfare-equivalent income necessitates value judgments to determine what constitutes welfare-enhancing forms of consumption, which costs and benefits are added or deducted from consumption, and how these costs and benefits are measured (Talberth et al. 2007). As a result, there are more subjective elements involved in estimating the GPI, compared to the GDP, which entails lumping together every exchange that goes through the market. However, much of these decisions in the estimation of GPI are grounded in core principles of sustainable development and social science.

GPI COMPONENTS

The GPI begins with a measure of personal consumption expenditures (including durable goods, nondurable goods, and services). National estimates of personal consumption expenditures are available for the U.S. and correlated with personal income data available for each state. This economic aggregate provides the starting point for the Utah GPI study, from which 24 different adjustments are made (Figure 1). The first adjustment is for income distribution, which corrects for the overstated consumption levels (material welfare) associated with income inequality. This correction is based on the premise that the additional benefit of a given increase in income is much smaller for high income families compared to families with lower incomes. Thus income inequality is a source of lopsided distribution of personal consumption that signals a loss in benefits of consumption for society. The inequality adjustment may also be interpreted as an estimate of the cost of loss of potential output for society as a whole due to unequal opportunities for investment or the erosion of social cohesion or social capital.

The value of positive non-market benefits (e.g., unpaid household work, volunteer work, and services provided by natural ecosystems) is added to the metric. Losses associated with economic activities that undermine quality of life (e.g., cost of crime, family breakdown, loss of leisure time, and cost of unemployment and underemployment) and that entail the loss of natural capital in the state (depletion of non-renewable resources and cost of air pollution) are subtracted from the measure. Following the conceptual framework described in the previous section, we have grouped the GPI components into three categories: economic, environmental, and social. We recognize that one of the goals of the GPI is to assess the interrelatedness of these three categories as they affect our collective welfare.

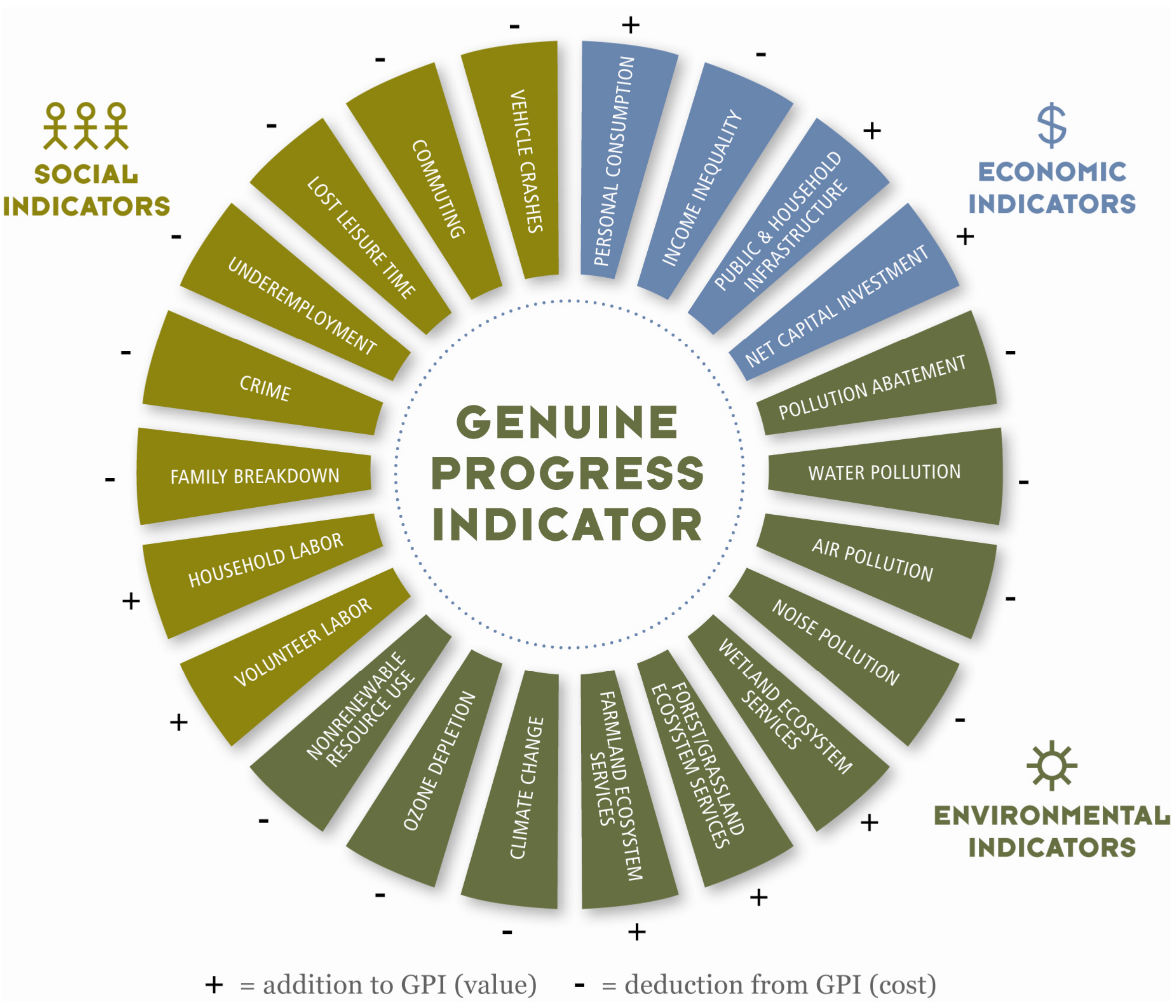


Figure 1. Economic, Social, and Environmental components of GPI.
Note: Positive and negative signs indicate whether the component typically is a positive or negative contribution to GPI. Please also note that this figure was updated in October 2011 to correct a small inaccuracy on the "Income Inequality" wedge.

PRIOR RESEARCH

ECOLOGICAL FOOTPRINT OF UTAH

In 2007, the Utah Vital Signs project completed the first state-level Ecological Footprint study in the U.S. (McIntyre et al. 2007). The Ecological Footprint is an ecological accounting tool that compares a particular human demand on the earth's biosphere in a given year to the available biological capacity in that year for a defined population and/or geographic area. Footprint analysis considers one key component of an overall review of the health of our environment, namely the amount of living ecological assets that yield goods and services on a continuous basis, with the important exception of water resources. Such a measure of supply relative to human demand on nature is important for tracking progress, setting targets, and driving policies for sustainability. The Global Footprint Network, with over 90 participants in its international Partner Network, developed standards for applying the Ecological Footprint methodology, and the Utah Vital Signs project adhered to those standards as a formal participant in the Partner Network.

Although the Ecological Footprint of the entire U.S. and the Ecological Footprint of the earth as a whole have been calculated at national levels for over 150 countries since 1961, this is the first state-level Ecological Footprint study in the U.S. The Ecological Footprint of the earth as a whole is calculated by the Global Footprint Network (2010) in conjunction with the World Wildlife Federation (WWF) International, which also publishes the Living Planet Report biannually (WWF 2010).

Utah's Ecological Footprint included how much food, energy, and other goods and services are being consumed by the average Utahn. The footprint is expressed in terms of the amount of land (in units of global hectares) required to produce these goods and services**.** A global hectare is a hectare (2.471 acres) with world-average ability to produce resources and absorb wastes. This average consumption is compared to the renewing capacity of Utah's land to determine whether we are living in a way in which our land could sustain us over time. In that way, it is partially a metric of self-sufficiency. It is also a metric of whether our consumption patterns are disproportionate to the amount of goods and services produced by our lands, thereby indicating whether Utah is a net contributor or debtor to global goods and services derived from natural resources. Another way to frame the study is through the following question: If everyone on earth lived the way that Utahns do, how many earths would we require?

The Utah footprint results were presented as an estimate of the global biocapacity in both global hectares per person and in global acres per person. The study provided a comparison between 1990 and 2003. The results of the Utah Ecological Footprint were compared with footprints from other areas (e.g., the U.S. as a whole and other countries) to help explain the importance of the Utah data.

The study found that as of 2003, Utah citizens were drawing more from nature than citizens from the U.S. as a whole, and more than the average world citizen, to support their consumption patterns. Given the large land area of Utah as compared to the size of its population, until recently, the biocapacity of Utah met the demands that Utahns placed on it. This was despite the relatively low net primary productivity (NPP) of the arid landscape. In 1990, the first year of the study, Utah was living within its ecological means. With only 20 people per square mile in 1990, our land was yielding enough renewable capacity on an annual basis to support our population and lifestyle. Although our consumption was still not frugal enough for planetary balance, we were consuming within the means of nature to renew its bounty to us within the state.

However, some time in the early part of this decade, Utah slid into ecological deficit. From 1990 to 2003, Utah's population increased by approximately 700,000 people; this coupled with an increase in the consumption per person resulted in an increase of demand of an estimated 8.6 million global hectares, an increase of 66% over the 1990 level. At the same time, the state's biocapacity decreased by the equivalent of 4.5 million global hectares, a decrease of 17.5%. The reported decrease in biocapacity was driven by land use and land-cover changes (including the loss of forests and agricultural land to development), albeit the calculations were complicated by different sources of land-use data for 1990 and 2003. The amount of this change that is due to differences in data sources is unknown. Nonetheless, the study points to an ecological deficit by 2003, placing Utah in ecological overshoot (Figure 2). This means that Utah citizens in 2003 were consuming approximately 11% more of nature's annual "interest" of renewable biological capacity than the lands of Utah provided.

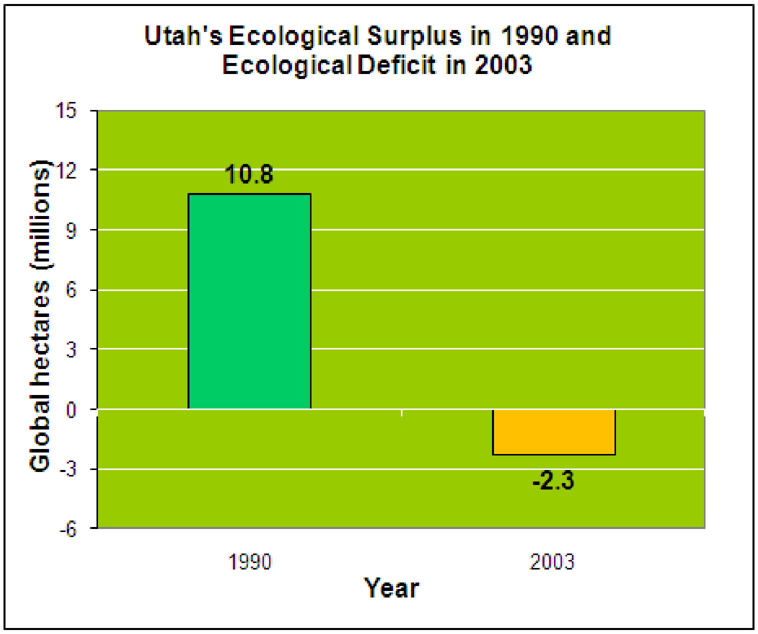


Figure 2. Change from ecological surplus to ecological deficit in Utah over 13 years.

Given the importance of maintaining an adequate ecological reserve for Utah, calculating the Ecological Footprint was an illuminating exercise when considered as part of decisions affecting stewardship of the land and waters of Utah. On an individual level, Utah's Ecological Footprint can help us understand our consumption patterns and which consumption components contribute most to "living beyond our means." Although the Footprint study by itself does not advocate or promote any particular strategy, policy, or solution, it suggests that there are many opportunities to work together to decide our individual and collective futures.

QUALITY OF LIFE AND WELL-BEING OF UTAHNS

In 2007, Envision Utah, an organization that promotes quality growth in Utah, released a study on *Utah Values and Future Growth* that aims to identify the values and priorities of Utahns so they can be reflected in Utah planning policies and processes (Envision Utah 2007). The study focused on the quality of life of Utahns, as reported by residents; as such, it is a study of subjective well-being. The study compared results from 2007 to a study completed in May 1997 to assess how our quality of life, as perceived by Utahns themselves, changed over time. The study relied on a survey of 1,262 Utah citizens. The report indicates that Utahns rate their quality of life a 6.4 on a 10-point scale (with 10 representing the best possible life), which is similar to the average reported by Americans across the country. This result represents a decrease in perceived quality of life, down from 7.3 (by 12%) reported in 1996. In 2007, Utahns also reported high expectations (7.3 out of 10) for an improved quality of life in the future, which is also similar to other reports across the U.S. (7.4 out of 10) but is noticeably less than the 8.2 rating Utahns gave to their future in 1996.

The factors that influence quality of life opinions in Utah are primarily living in a safe community with low crime, a sense of being close to family, and enjoying the outdoors and nature. The latter two factors are of greater importance for Utahns than for the average U.S. citizen. Indeed, many national studies, including Robert Putnam's *Bowling Alone* (2000), support that Utah scores very high compared to other states on social capital and civic engagement. In addition, Utahns report increasing concerns about the impacts of growth on quality of life. In 1996, over 80% of Utahns believed that movement of new businesses in the state would lead to overall improvements in quality of life. By 2007, that number had been reduced to 58%. When asked which element had the largest impact on their quality of life, Utahns listed crowding, traffic, lack of diversity, and lack of affordable housing (Envision Utah 2007).

According to the 2009 Gallup-Healthways Well-Being Index State and Congressional District reports, another study that looks at subjective well-being, Utah had the second highest rating of all states in the country for overall well-being. The Gallup-Healthways Well-Being Index is a quality of life index that incorporates life situation, emotional health, physical health, healthy lifestyle, work environment, and basic access to food, shelter, healthcare, and a safe place to live (AHIP 2010). This study was based on surveys of individuals.

Utah continues to rate in the top 10 states in the country in terms of overall health (America's Health Ranking 2010). The annual ranking, published by the United Health Foundation and funded by insurer United Health Group, indicates that Utah ranks especially high in terms of low smoking rate, low prevalence of binge drinking, low rate of preventable hospitalizations, low violent crime, low infant mortality, and low rate of cancer deaths. However, between 2009 and 2010 Utah's rank dropped from the second healthiest state (just behind Vermont) to the 7th healthiest state. The ranking identifies the following challenges to Utahns' health: 1) increased percentage of children in poverty; 2) limited availability of primary care physicians; 3) high disparity within the state; and 4) low public health funding. Although GPI does not directly account for all health-related aspects of well-being, health care impacts associated with poor air quality, car crashes, and crime are accounted for in the study.

RESULTS OF OTHER LOCAL GPI STUDIES

While the GPI methodologies were initially developed for national level assessments, there is a growing interest in applying GPI methods at the state, county, and regional scales due to the impact that local policies can have on well-being. To date, local GPI studies in the U.S. have been completed in Vermont (Costanza et al. 2004), Ohio (Bagstad and Shammin 2009), Minnesota (Minnesota Planning Environmental Quality Board 2000), the San Francisco Bay Area (Venetoulis and Cobb 2004), Maryland (State of Maryland, 2010), and the Northern Forest (Bagstad and Ceroni 2007), Michigan (Michigan State University), and the Alberta province in Canada (Anielski et al. 2001). There is also an effort in progress in Massachusetts (Assumption College) to complete state-level GPI studies (Figure 3).

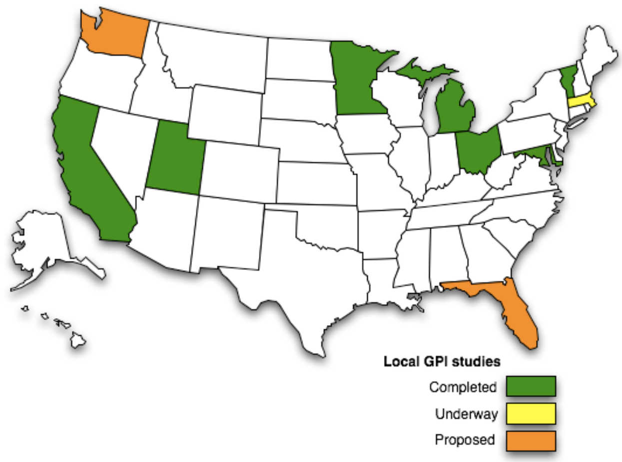


Figure 3. States with GPI studies either completed or underway as of 2010.
Source: Kenneth Bagstad, University of Vermont

In many of the national-level GPI studies completed for developed countries in North America and Europe, GPI tends to increase through the mid-1980s and then begins to level off or decrease through the present, thereby diverging from the rising trend in GDP (Figure 4). In other words, the costs associated with GDP growth (loss of natural capital, breakdown in social systems, rising income inequality) eventually outpace the benefits to individual well-being associated with both market-bought goods and services and the imputed values of household and volunteer labor included in the GPI. This divergence is consistent with the threshold hypothesis in the early ecological economics literature, which posits that after a threshold level of economic activity, the quality of life of a community appears to stabilize or deteriorate (Max-Neef 1995). A similar pattern was observed in the Ohio GPI study, although the threshold for Ohio appeared to be in 2000, rather than in the 1980s (Bagstad and Shammin 2009). The Vermont GPI study found that the GPI continued to increase through 2004 when the study was completed**.** In the Maryland GPI study, aggregate GPI leveled off in the 1980s and 1990s but began to increase again in 2000 (State of Maryland 2010). Although this pattern is observed for aggregate GPI of Maryland, when the effect of population growth is included (i.e., GPI is expressed in per-capita terms), it disappears. Because the values (costs or benefits) of key GPI components differ substantially in different parts of the country, it is not unexpected that GPI would peak at different time periods in different parts of the country. However, the methods were generally held consistent across the state-level studies to facilitate comparison.

The Ohio GPI study also found that per-capita GPI was the highest in suburban counties and lowest in urban areas. Conversely, the more urbanized areas of Vermont generally had a higher per-capita GPI than the rural areas of the state. The most important positive contributions to GPI in Ohio were the value of household and volunteer labor. The largest negative components for the Ohio GPI were nonrenewable resource depletion, climate change, and ozone depletion. In addition to these factors, the loss of leisure time and the costs of commuting also were among the most negative components of the Vermont GPI.

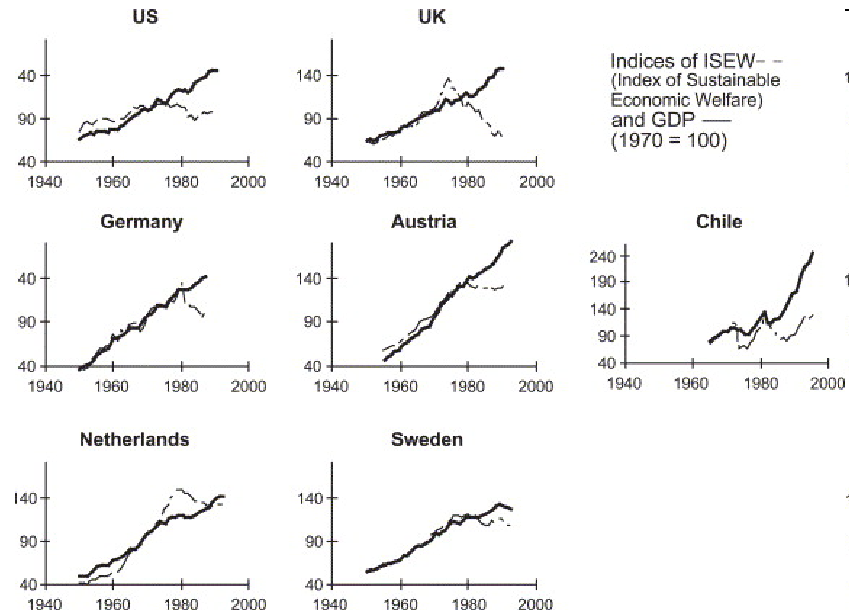


Figure 4. Comparison of GDP and ISEW (precursor to GPI) for industrialized counties.
Source: Costanza et al. 1997a, 1997b.

UTAH GPI APPROACH

STUDY BOUNDARIES

The Utah GPI study focuses on trends since 1990, which represents the first year with historically reasonably good local data availability for many of the components. We calculated the GPI at five-year intervals (1990, 1995, 2000, and 2005). In addition, we calculated GPI for 2003 in order to match the results from the Utah Ecological Footprint study. We also included a GPI calculation for 2007, which represented the most recent year for data availability when we began the study in mid-2009.

The Utah GPI study includes a state-level calculation as well as county-level estimates of GPI for the state's six most populous counties: Cache, Davis, Salt Lake, Utah, Washington, and Weber. These counties were selected because there are data available for them through the American Community Survey produced by the U.S. Census Bureau and the American Time Use Survey (BLS 2010a), which give good socioeconomic and demographic data for non-Census years.

The Utah GPI is reported in 2000 U.S. dollars. The nominal values of aggregates or unit values (prices) reported for years other than 2000 were converted to 2000 U.S. Dollars using the Consumer Price Index. The GPI accounts that include the data, data sources, and calculations for all components of the GPI are available in a spreadsheet on the UPEC website www.utahpop.org/gpi.html.

POPULATION

Many of the calculations used in the GPI study rely on estimates of population at the state and county level. In addition, most of the GPI components are calculated in both aggregate and per-capita terms.

Table 1. Population in Utah and selected counties

	1990	1995	2000	2003	2005	2007
Cache County	70,560	82,095	91,897	98,176	103,564	109,022
Davis County	188,471	216,054	240,204	262,038	278,278	296,029
Salt Lake County	728,298	827,342	902,777	940,465	978,285	1,018,904
Utah County	265,766	310,334	371,894	423,286	456,073	501,447
Washington County	48,988	72,910	91,104	109,767	127,127	140,908
Weber County	158,673	178,094	197,541	205,882	213,684	220,781
State of Utah	1,729,227	1,995,228	2,246,553	2,413,618	2,547,389	2,699,554

ECONOMIC COMPONENTS

PERSONAL CONSUMPTION

The starting point for calculating the GPI is personal consumption expenditures on goods and services by households, which is widely seen as both the key measure of material welfare and the primary engine of future economic growth (Daly and Cobb 1989; Eisner 1994). Personal consumption is an appropriate starting point for the GPI because we are interested in measuring progress in welfare generated by household consumption, rather than the total monetary value of production. Personal consumption constitutes the largest component of the U.S. GDP. In 2007, it accounted for 70% of domestic final expenditures in the U.S. (Economic Report of the President 2009). Personal consumption includes a wide range of expenditures on durable and nondurable consumer goods, including imported goods and services. Personal consumption expenditures include all spending by households, including consumer goods such as groceries, clothes, cars, and appliances; services such as health care, childcare, haircuts, college education, transportation, and vacations. Most of the personal consumption spending by households is on new goods and services supplied by private businesses; however, personal consumption also includes purchases of new goods and services from the government or government enterprises, such as fees for various services, licenses, etc. In National Income and Product Accounts (NIPA), personal consumption expenditures are valued at market prices, which include sales and excise taxes (Landefeld et al. 2008).

ESTIMATION OF PERSONAL CONSUMPTION AT THE STATE AND COUNTY LEVEL

The NIPA do not provide estimates on personal consumption expenditure information at the state or county level. As a result, state GPI studies have used the U.S. ratio of consumption to personal income (i.e., the *average propensity to consume*) to estimate personal consumption levels based on state or county income data (BEA 2009). The U.S. average propensity to consume ranged from 78.7% in 1990 to 83.3% in 2007. Thus we estimate per-capita consumption in each county and the state) by multiplying the per-capita income in the county and the state by the U.S. average propensity to consume. This method assumes that each year, consumers in Utah and its counties spent the same percentage of their income on personal consumption as the U.S. average. In turn, we multiplied per-capita consumption levels by the population to arrive at total consumption levels in the state and each county expressed in 2000 USD.

In Table 2 we show the derivation of personal consumption for 2005 as an example. Beginning with personal income at the county and state level, we adjust for inflation and multiply by the average U.S. propensity to consume to derive personal consumption. To improve on these consumption estimates, we next incorporated Utah-level consumer spending data compiled by the Environmental Systems Research Institute (ESRI) from Consumer Expenditure Surveys conducted by the Bureau of Labor Statistics (BLS). ESRI provides actual consumption data on detailed products and services at the state and county levels. The consumption items in ESRI data include nondurables (e.g., food, clothing), durables (e.g., cars, lawn movers), and services (e.g., tuition payments, healthcare costs, insurance costs, movie tickets). Using the county- and state-level ESRI consumption data that are indexed to the U.S. average (which is set at 1), we derive more accurate consumption spending estimates at the local level. Table 2 shows that the indexed consumption levels in Davis, Salt Lake and Utah counties (1.18, 1.10, and 1.03, respectively) are higher than the U.S. average. The Utah average is 0.91**.** We multiply the state and county personal consumption levels by the ESRI indexed spending to obtain the final personal consumption values used in the GPI calculation (see the second to last column of Table 2).

Table 2. Calculation of personal consumer spending index, per capita (2000 USD)

	Personal Income (2005)	Personal Income Adjusted for Inflation† (2005)	Personal Consumption‡ (2005)	ESRI Indexed Spending	Personal Consumption Adjusted with ESRI Index	Personal Consumption adjusted for alcohol, tobacco, junk food
Cache County	$22,075	$19,463	$16,477	0.87	$14,335	$13,902
Davis County	$28,151	$24,821	$29,194	1.18	$34,449	$33,409
Salt Lake County	$32,804	$28,924	$34,020	1.10	$37,422	$36,291
Utah County	$21,066	$18,574	$21,846	1.03	$22,501	$21,822
Washington County	$21,901	$19,311	$22,713	0.81	$18,397	$17,842
Weber County	$27,199	$23,981	$28,207	0.95	$26,796	$25,987
State of Utah	$27,527	$30,587	$28,546	0.91	$25,977	$25,193

† Inflation adjustment factor of 88.2% to express in 2000 USD
‡ Americans spent 84.7% of personal income on consumption in 2005 (BEA 2010)

At this stage we made one further adjustment to personal consumption expenditures to reflect the spending that reduces well-being. We deducted spending on tobacco, alcohol, and junk food, following the deduction percentages suggested by Lawn (2005): all of tobacco consumption, half of alcohol consumption, and 20% of food consumption designated as expenditure on junk food. We justify these deductions on the basis of the scientific consensus that these consumption categories constitute major risk factors for heart disease, diabetes, and obesity, and premature deaths. We estimated Utahns' spending on these items on the basis of average U.S. data, and then made a further adjustment to reflect the lower levels of consumption of alcohol and tobacco in the state relative to the national average. Accordingly, this adjustment amounts to a deduction of between 3.9% in 1990 and 2.9% in 2007 from the personal consumption expenditures in the state (see final column of Table 2 to see this step in the 2005 example).

To make this last adjustment we relied on the BEA personal consumption expenditure data by type of commodity for the U.S. in 1997 and 2002 (BEA 1997; 2002), from which we obtained the share of consumption on alcohol, tobacco, and junk food consumption in total personal consumption expenditure for the U.S. The National Institute of Alcohol Abuse and Alcoholism and the Centers for Disease Control report state-level annual data on alcohol consumption per capita and the cigarette-smoking prevalence rate, respectively, from which we determined Utah consumption levels relative to the U.S., and used this ratio to estimate the dollar value of consumption on these items in the state (NIAA 2010; CDC 2010a). In 2007 Utah had the lowest cigarette-smoking rate among the states, which was 11.7% relative to the U.S. median of 19.8%, or 59% of the U.S. rate. Similarly, in 2007 Utahns' per-capita alcohol consumption was 58% of the U.S. average, the lowest among the states.

This type of deduction results in a small downward adjustment in personal consumption expenditures, which might be smaller than the future health-care expenditures needed to address the consequences of consuming these products. It is arguable that deduction of health-related expenditures is more appropriate if we are concerned about reflecting the well-being (the psychic income) of individuals. We have not pursued this alternative route in large part due to lack of estimates for the state for the entire study period. Available studies suggest, however, that this alternative adjustment would likely amount to a sizable deduction from personal consumption. For example, in 1999-2000 the obesity-attributable personal medical expenditures in Utah (excluding Medicare and Medicaid spending) were estimated as 260 million USD (in 2003 constant dollars) (Finkelstein et al. 2004). Likewise, the average annual smoking-attributable medical expenditures (non-Medicaid) and productivity losses in the 2000-2004 period amounted to 663 million USD in the state (Tobacco Free Utah 2010). Thus personal health expenditures associated with obesity and cigarette smoking alone constitute 1.8% of personal consumption expenditures in the state in 2000. Additional ill health consequences of junk food and excessive alcohol consumption would further expand these health expenditures.

When all of the above-described adjustments are made to personal income we obtain the per-capita consumption estimates in each county reported in Table 3. In 2007, personal consumption per capita ranged from $39,128 in Salt Lake County to $13,371 in Cache County, with the state average at $27,026. On a per-capita basis personal consumption in Utah rose steadily, doubling from $13,537 in 1990 to $27,026 in 2007. Total personal consumption for each county is calculated by multiplying per-capita consumption by population estimates reported in Table 1 (UGOPB 2009).

Table 3. Personal consumption, per capita (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$11,424	$11,991	$12,587	$13,296	$13,902	$13,371
Davis County	$17,687	$22,125	$29,668	$30,491	$33,409	$36,403
Salt Lake County	$18,169	$22,874	$30,449	$31,813	$36,291	$39,128
Utah County	$12,319	$16,337	$20,226	$19,888	$21,822	$23,003
Washington County	$10,154	$12,737	$15,617	$15,625	$17,842	$18,550
Weber County	$15,164	$18,383	$22,145	$24,234	$25,987	$28,464
State of Utah	$13,537	$16,966	$21,752	$22,500	$25,193	$27,026

INCOME INEQUALITY ADJUSTMENT

As an indicator of economic prosperity, income or consumption per person is a statistical artifact that assumes each individual in the nation or state has an identical share of total income or consumption. The more unequal the distribution of income or consumption expenditure among households in the state, the more unrealistic is the presumption of an equally shared material welfare signaled by these average magnitudes. Further, growth of personal consumption yields differing benefits to individuals in the context of inequality. Due to the diminishing benefit of income, wealthier groups gain less from a given increase in income compared to lower-income groups. For example, the purchase of an additional sports car has less marginal benefit or utility for the very wealthy and for society than does meeting basic needs for low-income families. Therefore, in order to provide a better assessment of economic prosperity than personal consumption data alone the GPI methodology incorporates information on the income distribution at the local level and adjusts growth in personal consumption expenditures by the change in income inequality.

Income inequality describes the income differences between households. Households whose members have higher levels of education and own more assets (e.g., stocks, bonds, real estate) receive higher incomes. Inequality is a typical feature of market economies and some level of inequality is deemed necessary by many as a signal of greater rewards for those who work harder and take greater risks. High levels of inequality, however, are commonly viewed as a source of feelings of injustice by groups who feel left behind, social tensions, and are considered reflective of an unfair distribution of prosperity. In addition, high levels of inequality generate inefficiency, in the sense of loss of potential output for society as a whole due to unequal opportunities for investment (Todaro and Smith 2009). These inefficiencies are generated when lower-income families are unable to set up businesses for lack of credit or send their children to college, which in turn would lead to lower output or prevent increase in the number of more productive citizens in the next generation. Some, on the other hand, argue that income inequality in a given year should not be a cause for concern if there is upward mobility in society, that is, if families in lower-income groups are able to move up to higher-income groups over time. Thus, in assessing the effect of inequality on well-being it is important to consider the extent of upward mobility, which could offset the negative effects.

Along with other GPI studies, we used the Gini coefficient, a measure of statistical dispersion used in economics, as the measure of overall household income inequality for Utah. This measure identifies the percent of income each segment of the population receives, for example, the poorest 20% of the population receives 12% of overall income and so on, and measures these income shares over the entire population. The Gini coefficient compares the actual income distribution with an equal distribution of aggregate income. The coefficient values range from the hypothetical values of zero to 1, zero representing perfect equality (where each household receives the same income) and 1 representing perfect inequality (where one household receives all the income in society). Coefficient values in the 0.20s-0.30s indicate low levels of inequality. Internationally, Gini coefficient values in the 1990s and early 2000s ranged from 0.247 in Denmark to 0.632 in Lesotho (UNDP 2007).

For the U.S., the Census Bureau tracks Gini coefficients for the nation as a whole, but not at the state or county level. As a result, for the Utah study we followed the earlier GPI studies and used Nielsen and Alderson's county-level income inequality data for 1970 and 1990 (Nielsen and Anderson 1997). For 2000, 2003, 2005, and 2007 we calculated the Gini coefficients based on the U.S. Census Bureau's family income data and Nielsen's publicly available software for estimating Gini coefficients (Nielsen 2010).

Table 4 shows that from 1990 to 2007, the Gini coefficient values in Utah remained relatively stable, with the state Gini ranging from a low of 0.363 to 0.376. These magnitudes contrast with the U.S. Gini coefficient that rose from 0.428 to 0.466 between 1990 and 2007 and from its lowest post-World War II value of 0.386 in 1968 (USCB 2010). Compared to other states Utah has lower levels of inequality. According to the Center on Budget and Policy Priorities (2008) estimates, Utah had the lowest level of income inequality among 50 states in the early 2000s. The Center on Budget and Policy Priorities uses the top-to-bottom ratio for its measure of inequality, which focuses on the gap between the two ends of the income distribution, unlike the Gini coefficient that takes the entire distribution into account. According to the top-to-bottom ratio measure, the average income share of the richest 20% of Utahns was 4.4 times as much as those of the poorest 20% of Utahns in the late 1980s. This ratio increased to 4.9 in the late 1990s and further to 5.4 by 2005 (USCB 2010a).

While the Gini coefficients indicate low and stable levels of income inequality in Utah, they are likely to be underestimates. A recent study by the Utah Foundation (2010) indicates that inequality in Utah is greater than that reported for the state in Table 3. The Utah Foundation study relies on a recent methodology developed by the U.S. Department of Treasury, which tracks the change in household income for all households that file federal income taxes. This methodology provides a greater level of accuracy on household income levels, particularly at the high end of the income distribution, than that possible based on Census or survey data. Greater accuracy is attained in large part because taxpayer data provide information for the entire group of taxpayers whereas the U.S. Census data have a small sample size and do not provide accurate information on incomes of the highest income groups. The Gini coefficients calculated on the basis of the tax returns data indicate that the Gini for Utah rose from 0.48 in 1995 to 0.55 in 2000, and fluctuated between 0.53 in 2003, 0.56 in 2005, and 0.55 in 2007. The Utah Foundation study also shows a high level of income mobility in Utah. However, the mobility was not confined to upward mobility. In fact, only 32% of taxpayers moved up to a higher-income group between 1994 and 2007, even as 80% of taxpayers in the state experienced an increase in household income. Moreover, 34% of taxpayers experienced decline in their relative income status, moving down to a lower income group over this period. Thus, although Utah taxpayers experienced a high level of income mobility, half of the mobility was downward, rather than upward, suggesting that the concern about rising inequality is valid.

Since county-level Gini coefficient estimates based on the taxpayer data are not yet available and the new methodology is not yet widely used, in the Utah GPI study we used the Gini estimates reported in Table 4 to adjust household consumption levels for income inequality. Applying the newly estimated Gini coefficients for the state indicates a substantial downward adjustment in personal consumption and the GPI (a negative adjustment of

$10,818 per capita to personal consumption in 2007 compared to our current adjustment of $2,771). Future GPI studies should use the new and more accurate methodology for the income-inequality adjustment.

Table 4. Household income inequality: Gini coefficients for Utah

	1990	2000	2003	2005	2007
Cache County	0.347	0.378	–	0.401	0.356
Davis County	0.322	0.343	0.317	0.346	0.367
Salt Lake County	0.367	0.371	0.388	0.385	0.366
Utah County	0.374	0.370	0.370	0.378	0.372
Washington County	0.356	0.370	–	0.389	0.367
Weber County	0.332	0.358	–	0.348	0.345
State of Utah*	0.369	0.372	0.363	0.376	0.368

* State-level Gini coefficients for 1990 and 2000 are based on family income data from U.S. Population Census, whereas the Gini coefficients for 2003, 2005, and 2007 come from *The American Community Survey*. Calculations for 2000, 2003, 2005 and 2007 are based on Nielsen (2010). No data were available for 1995, and in 2003 data were only available for 3 counties. Gini coefficients for missing years were estimated using linear interpolation of trends.

In order to obtain an income distribution-adjusted personal consumption level in Utah and in each county we calculated an income inequality index by taking the 1970 levels of Gini coefficients for each county and the state as the base values. Because U.S. income inequality was at its lowest post-World War II levels in the late 1960s and early 1970s the 1970 U.S. Census data serve as an apt reference point for the changes thereafter. Thus, following other GPI studies we set the inequality index for Utah at 100 in 1970 when Utah's Gini coefficient was 0.33. We generated the inequality index values for the years in the Utah study by dividing the Gini coefficient for each year by the Gini for 1970. The inequality index has remained fairly constant between 1990 and 2007, hovering around 111–114 (relative to 100 in 1970).

Table 5 reports the per-capita consumption levels adjusted for inequality. The values in Table 5 are the per-capita personal consumption levels reported in Table 3 divided by the income inequality index for each county and the state (Table 4). The inequality adjustment reduces the personal consumption levels in the state and most of the counties, because inequality has increased since 1970 (albeit not by much since 1990). The exceptions are Cache and Washington counties that had lower levels of income inequality in 1990 (and Washington County in 2000, 2007) compared to 1970. Table 6 reports the difference between the actual consumption levels and the inequality adjusted-consumption levels in the aggregate. For most counties and the state as a whole, income inequality results in consumption losses (expressed as negative magnitudes). As such, the negative figures reflect the inefficiency associated with inequality. However, these losses are smaller than would have been the case had the state experienced the sharp increases in inequality at the national level in recent decades.

Table 5. Personal consumption adjusted for income inequality, per capita (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$11,991	$12,051	$12,111	$12,370	$12,628	$13,671
Davis County	$14,967	$19,264	$23,561	$26,168	$26,287	$27,020
Salt Lake County	$17,219	$22,877	$28,536	$28,546	$32,809	$37,182
Utah County	$11,128	$14,796	$18,465	$18,161	$19,494	$20,847
Washington County	$10,991	$13,627	$16,264	$16,963	$17,663	$19,465
Weber County	$15,023	$17,693	$20,364	$22,488	$24,612	$27,169
State of Utah	$12,108	$15,710	$19,312	$20,444	$22,128	$24,255

Table 6. Income inequality adjustment to personal consumption in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$567	$59	-$476	-$927	-$1,274	$301
Davis County	-$2,720	-$2,861	-$6,107	-$4,323	-$7,122	-$9,383
Salt Lake County	-$951	$3	-$1,912	-$3,268	-$3,482	-$1,946
Utah County	-$1,190	-$1,540	-$1,762	-$1,727	-$2,328	-$2,156
Washington County	$837	$891	$646	$1,338	-$179	$915
Weber County	-$141	-$689	-$1,781	-$1,746	-$1,375	-$1,295
State of Utah	-$1,429	-$1,256	-$2,440	-$2,057	-$3,064	-$2,771

SERVICES AND COST OF CONSUMER DURABLES

Personal consumption expenditures, the starting point for GPI calculation, include spending on consumer durables. In the standard GDP methodology spending on consumer durables is counted in the year of purchase. Because these are products that last three or more years, the GPI aims to include only the annual value of the services provided by them, rather than their total purchase price (cost) to consumers. As a result, we undertook a two-step calculation to estimate the value of the stock of consumer durables and the value of their annual services. The former is deducted from GPI and the latter is added to the GPI. In estimating the cost of acquiring the consumer durables we used the national estimates of the cost of consumer durables reported in Talberth et al. (2007) as our starting point. We calculated the total spending on durables in Utah by using the indexed spending values for Utah in Table 7. Rapid growth in total levels of spending on durables since 1990 (Table 8) reflects the overall increase in the material wealth of Utahns. We followed the same approach in estimating the annual value of services Utahns received from consumer durables. Table 9 shows that the annual value of services of consumer durables steadily increased from 3.6 billion to 7 billion between 1990 and 2007. Beyond 2000, however, the total spending on consumer durables rose faster than the value of their services, resulting in negative returns to personal consumption expenditures (Table 10). It is possible to explain this result by the reduced quality of consumer durables, decline in the built-in obsolescence period for some consumer durables, faster rate of technological change and emergence of new products after 2000, and/or the desire by consumers to update consumer durables prior to their expected life.

Table 7. Indexed consumer durables spending in 2008

Cache County	83.7
Davis County	114.4
Salt Lake County	105.3
Utah County	100.2
Washington County	78.5
Weber County	90.1
State of Utah	98.6
United States	100

Table 8. Total cost of consumer durables in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$107.4	$144.5	$235.3	$291.1	$335.0	$381.4
Davis County	$392.1	$519.9	$841.0	$1,062.3	$1,230.9	$1,416.1
Salt Lake County	$1,394.2	$1,831.7	$2,908.1	$3,508.1	$3,981.3	$4,484.6
Utah County	$484.3	$654.0	$1,140.4	$1,503.0	$1,766.8	$2,100.9
Washington County	$69.9	$120.3	$218.8	$305.2	$385.7	$462.3
Weber County	$259.9	$337.4	$544.5	$657.1	$744.1	$831.5
State of Utah	$3,099.8	$4,136.6	$6,776.6	$8,430.7	$9,708.0	$11,126.2

Table 9. Total value of services of consumer durables in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$125.7	$152.3	$184.9	$204.2	$223.4	$241.6
Davis County	$459.0	$548.0	$660.8	$745.1	$820.6	$897.0
Salt Lake County	$1,631.9	$1,930.7	$2,285.1	$2,460.4	$2,654.3	$2,840.6
Utah County	$566.9	$689.4	$896.1	$1,054.2	$1,177.9	$1,330.8
Washington County	$81.8	$126.8	$171.9	$214.1	$257.1	$292.8
Weber County	$304.2	$355.6	$427.8	$460.9	$496.1	$526.7
State of Utah	$3,628.4	$4,360.0	$5,324.8	$5,913.0	$6,472.1	$7,047.5

Table 10. Net value of consumer durables (value of services – cost of durables) in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$18.3	$7.8	-$50.4	-$86.9	-$111.7	-$139.8
Davis County	$66.9	$28.1	-$180.2	-$317.3	-$410.3	-$519.1
Salt Lake County	$237.7	$98.9	-$623.0	-$1,047.6	-$1,327.0	-$1,644.0
Utah County	$82.6	$35.3	-$244.3	-$448.8	-$588.9	-$770.2
Washington County	$11.9	$6.5	-$46.9	-$91.1	-$128.5	-$169.5
Weber County	$44.3	$18.2	-$116.6	-$196.2	-$248.0	-$304.8
State of Utah	$528.6	$223.4	-$1,451.8	-$2,517.7	-$3,235.8	-$4,078.7

NET CAPITAL STOCK GROWTH

The GPI seeks to measure not only the current well-being of Utahns but also to ascertain whether this well-being is economically sustainable. In order to sustain its level of consumption the state has to maintain its stock of built capital—factories, machines, and tools used to create goods or services that are not themselves used up in the production process. Likewise, if the state invests more than the level needed to maintain its current stock of capital this investment will provide for higher consumption levels in the future. If the state fails to either increase or maintain its capital stock, it would be consuming its investible funds as income. However, to be consistent with the notion of current income underlying GPI, the net increase (or decrease) in total stock of producer goods cannot be added to (or deducted from) personal consumption expenditures. Thus the inclusion of net capital stock growth in the GPI has been a subject of debate. We followed Daly and Cobb (1989), who favored inclusion and proposed that the additions to capital stock (investment) be calculated as the increase in capital stock above the amount needed to keep the quantity of capital per worker constant over time. They outlined the methodology used in the ISEW and GPI studies. Accordingly, the net capital stock growth is measured as the difference between actual change in capital stock and the change in required level of capital stock that is commensurate with the labor force growth.

In the absence of capital stock estimates for Utah, we relied on national estimates of the change in net stock of private nonresidential fixed reproducible capital reported in Talberth et al. (2007) and extrapolated the values for 2005 and 2007. Thus our GPI estimates assume that the national-level changes in the capital stock apply to Utah and each of the six counties in this study. Positive values in Table 11 indicate that in the study years, on a per

Table 11. Net capital growth per capita for Utah (2000 USD)

	1990	1995	2000	2003	2005	2007
State of Utah	$401	$682	$1,690	$1,282	$1,267	$1,287

person basis, the capital stock grew more than the increase needed to keep the capital-labor ratio constant from one year to next. Multiplied by the population of Utah these per-capita estimates provide the estimates of total net capital investment in the state. GPI considers this positive increment in capital stock as an addition to the GPI.

SERVICES OF STREETS AND HIGHWAYS

A considerable amount of government spending involves additions to publicly-provided built capital that provides services in future years. Government spending to maintain and build streets and highways constitutes one such expenditure. Streets and highways provide a benefit that is usually not directly paid for by individuals in the form of fees or tolls, and hence these services are not included in the personal consumption expenditures. In keeping with the conceptual distinction between current income and capital underlying the GPI, the increase in the stock of streets and highways cannot be added to the GPI as current income, but rather the annual value of the services they provide is included.

Table 12. Value of services provided by streets and highways in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$24.4	$25.9	$33.0	$34.8	$43.5	$58.1
Davis County	$19.2	$21.0	$29.0	$35.2	$40.3	$50.7
Salt Lake County	$61.2	$66.9	$90.5	$96.4	$124.0	$153.5
Utah County	$48.2	$49.3	$69.9	$75.0	$93.2	$117.0
Washington County	$30.4	$33.0	$43.6	$46.8	$55.8	$72.3
Weber County	$21.1	$23.1	$29.3	$32.4	$40.9	$50.4
State of Utah	$955.9	$954.7	$ 1,144.5	$ 1,207.9	$ 1,479.8	$ 1,804.6

We obtained the length of streets and highways in the state of Utah from the U.S. Department of Transportation, Federal Highway Administration website (USDOT, 1990, 1995, 2000, 2003, 2005, 2007). We expressed the state mileage as a share of total US mileage. Similarly, we obtained Utah's Total Public Road Mileage (by county) from the Utah Department of Transportation (UDOT). The BEA reports the total national stock value of streets and highways. We multiplied the state's share of U.S. mileage with this national value to obtain the value of the state's roads. In turn, we multiplied this value by 7.5% to convert the stock value into an annual flow of social benefits. The 7.5% adjustment is based on the assumption that the annual value of these services is 10% of the net stock value of the streets and highways (2.5% for depreciation and 7.5% for the average interest rate) and that 75% of the all vehicle miles are used for non-commuting purposes (i.e., 75% of 10% is 7.5%). The resulting value is the annual nominal service value of Utah roads, which we then expressed in 2000 dollars (Table 12). A similar calculation was done for the service value of county roads.

SOCIAL COMPONENTS

UNEMPLOYMENT AND UNDEREMPLOYMENT

GPI includes labor underutilization in the economy as an undesirable side effect of the market economy. This social cost is deducted in order not to overstate the benefits generated by economic activity. The standard measure of labor underutilization in the economy is *unemployment*. The official unemployment rate designates those in the labor force who are willing and able to work but are unable to find jobs as the unemployed, and measures the size of this group relative to the total labor force. The unemployment rate does not include those persons who are either chronically unemployed or have given up looking for work after a long job search (i.e., the *discouraged workers*) or those who work fewer hours than they would like to work (e.g., part-time workers who work for part or all of the year). *Underemployment* is a broader measure of labor underutilization that encompasses these groups of workers in addition to the unemployed. BLS began reporting estimates of broader measures of labor underutilization at the national level since 1994 and at the state level since 2005.

Underemployment is a source of inefficiency in the economy as it represents loss of potential output (income). As such, underemployment would be reflected in lower personal consumption levels. Beyond inefficiency however, underemployment generates important individual and social costs. Sen (1997) discusses the costs of unemployment in qualitative terms, many of which are difficult to calculate in monetary terms. The financial hardship of cyclical (short-term) unemployment is mitigated to some extent by unemployment insurance benefits that help maintain household consumption. Such incomes would be reflected in the personal consumption expenditures component of the GPI. However, the underemployed do not receive such compensation. Long-term unemployment and underemployment have adverse impacts on family life, entail loss of skills and motivation to work, and contribute to degradation of mental health and self-esteem and increased suicides in some individuals. Persistent joblessness also may weaken social values and responsibility, undermine cohesion of communities, and contribute to social exclusion (Sen 1997). Some of these social problems are captured by the GPI (e.g., divorce, crime); however, because not all of the associated social costs of underemployment are accounted for, the GPI deducts the cost of underemployment.

We estimate the social cost of underemployment in terms of the foregone earnings of underemployed workers. Specifically, to measure the cost of underemployment, we multiply the number of workers who are underemployed by the number of work hours they could not provide, and by the hourly wage rate. We depart from the methods used in previous GPI studies in estimating the cost of underemployment, in that we use annual state-level data rather than extrapolations based on U.S. data.[3]

Unemployment and Underemployment Trends in Utah

To estimate the number of workers who are underemployed, we relied on the Current Population Survey (CPS) March Supplement, which provides detailed information on employment characteristics of workers (CEPR 2010). We identified two groups of workers as underemployed: part-time, part-year workers; part-time, full-year workers.[4] For both groups, we identified those workers who *involuntarily* worked fewer hours than they desired.[5] This definition of underemployment does not include the discouraged workers who are no longer looking for work

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[3] Other GPI studies estimated the number of workers who are underemployed based on the unemployment rate by assuming a quadratic relationship between the unemployment rate and underemployment rate identified by Costanza et al. (2004). To estimate the number of "unprovided hours" per underemployed worker, these studies relied on the estimates for the U.S. reported in Leete-Guy and Schor (1992). For the years after 1990, GPI studies extrapolated the number of unprovided hours by assuming that these hours grew by 0.59% per year, which was the annual rate of increase between 1969 and 1989 reported by Leete-Guy and Schor. State GPI studies then assumed that the average unprovided hours per year for the U.S. applied at the local level.

[4] The identification of underemployed in the Utah study is based on the March CPS questions "Weeks worked last year," "Hours worked per week last year" and "full/part-time and year" status.

[5] Thus we left out those who declared that they wanted to work part time in response to the March CPS question "why less than 35 hours per week last year?"

and are classified as being out of the labor force. Almost all the workers in the March CPS engaged in paid work for at least some hours in the labor force in a given year, even if some may have been unemployed for most of the year. As such, our underemployed measure includes the workers who were unemployed at some point during the year. The number of underemployed as a share of total employment yields the underemployment rate for the state. Multiplying the labor force in each county by the state-level underemployment rate provides an estimate of the number of workers in each county who are underemployed.

Table 13 shows the unemployment and underemployment rates for Utah. The unemployment rates and the first set of underemployment rate figures for the state come from the BLS (BLS 2010a, BLS 2006), and the second set of estimates is based on the March CPS.[6] The period covered by the Utah GPI study was one of low unemployment and underemployment rates, nationally and in Utah. Even so, Utah had lower unemployment rates than the nation as a whole. The recessions of 1990–1991 and 2001–2002 are reflected in higher unemployment rates for 1990 and 2003. Annual BLS data for the 1990–2007 period show that Utah had its highest unemployment rate in 2002, at 5.8%, and lowest unemployment rate in 2007, at 2.6% (BLS 2010b). The last two rows of Table 13 show that despite the drop in the unemployment rate after 2003, the broadly defined underemployment rate for the state was at least twice as high as the unemployment rate in 2005 and 2007. Underemployment in the state based on the March CPS ranged from a low of 4.1% in 1990 to a high of 8.6% in 2003. On an annual basis, the underemployment rate for the state trended upward between 1990 and 2007.

Table 13. Unemployment and underemployment in Utah (%)

Data Source	1990	1995	2000	2003	2005	2007
Unemployment Rate						
BLS	4.4%	3.5%	3.4%	5.7%	4.1%	2.6%
Underemployment Rate						
BLS (U6)	–	–	–	–	8.0%	5.0%
March CPS	4.1%	5. 0%	4.5%	8.6%	7.8%	6.2%

COSTS OF UNDEREMPLOYMENT USED IN UTAH GPI

In addition to the number of underemployed workers, we estimated the number of work hours that were not provided by these workers. The *unprovided hours* are the difference between the average hours worked by underemployed workers and the average hours worked by full-time, full-year workers. Between 1990 and 2007, the annual hours of workers who were employed full-time, year-round increased from 2,263 to 2,297 hours per worker. Compared to full-time, full-year workers, the underemployed workers provide far fewer hours in the labor market. On average, the unprovided hours per underemployed worker increased slightly from 1,385 hours per year in 1990 to 1,452 hours per year in 2007, with considerable annual fluctuations around a flat trend over the entire period. As a share of total hours worked, unprovided hours trended upwards, increasing slightly from 3.2% to 4.7% between 1990 and 2007.

[6] The BLS estimates six alternative measures of labor underutilization, including the official unemployment rate (U3), for the U.S. since 1994 and for each state since 2005 (BLS 2010b). The underemployment rate estimates of the BLS (for example, U6 reported in Table 13) differ from our estimates due to the different reference period in the survey and the inclusion of different groups: while the March CPS asks about the usual weeks worked per year and usual hours worked per week, the BLS measure is based on last week's employment status and last week's hours worked, and includes those who dropped out of the labor force as underemployed.

The cost of underemployment is the product of the number of underemployed workers, the number of unprovided hours per underemployed worker per year, and the average hourly wage rate (in 2000 dollars) for each geography. For the state, these costs peaked at $2.1 billion in 2003, up from $0.7 billion in 1990 (Table 14).

Table 14. Cost of underemployment in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$23.7	$35.5	$41.8	$79.1	$69.3	$63.0
Davis County	$70.7	$102.8	$118.5	$213.8	$187.1	$170.6
Salt Lake County	$327.5	$479.0	$521.6	$886.5	$772.8	$717.1
Utah County	$92.9	$141.2	$174.5	$307.8	$274.0	$257.9
Washington County	$14.0	$28.4	$34.7	$70.7	$69.6	$67.4
Weber County	$63.2	$89.5	$99.2	$175.9	$149.0	$133.1
State of Utah	$686.8	$1,011.5	$1,159.6	$2,061.9	$1,790.6	$1,657.5

HOUSEHOLD WORK AND PARENTING

The myriad activities required to maintain households and care for family members are an important contributor to our well-being, but are unaccounted for in the GDP because the work is unpaid. These activities range from housework, parenting, and eldercare to repairs and cleaning required to maintain the physical housing stock. The GPI includes an estimate of the monetary value of these unpaid activities, which could be provided through the market and, if they were, would be included in the GDP.

One of the most common methods used for estimating the monetary value of household labor is to multiply the annual hours spent in these activities by the hourly cost to hire someone to do the equivalent housework or care giving in the home (i.e., the housekeeper replacement cost method). Our estimates of housework hours for Utah are based on time spent on three categories of unpaid home-based work: household activities, which include cooking, cleaning, and home repairs; caring for household members; and caring for non-household members. According to the 2003–2007 American Time Use Survey (ATUS) data, about a quarter of household labor hours are spent on housework and the rest is spent on caring for family members (BLS 2010c). The amount of time devoted to household labor is closely related to the labor market status of individuals, with the expectation that those employed are likely to perform fewer hours of household labor compared to those who are either out of the labor force, such as full-time homemakers, or are unemployed.

TRENDS IN HOUSEHOLD WORK AND PARENTING

Past national GPI studies have used national household work estimates by gender and employment status provided by Eisner (1989). These estimates were based on time-use studies conducted by the Michigan Survey Research Center in 1965, 1975, and 1981. In the Utah study we relied on the more recent ATUS, which was started in 2003. However, the small sample size for each state in the ATUS prevents obtaining annual estimates of household labor hours, which are differentiated by both employment status (i.e., employed, unemployed or out of the labor force) and gender. Hence, we used the same average household labor hours for the state for 2003, 2005 and 2007, drawn from pooled data from 2003 to 2007. Using the estimates for 1981 from Eisner (1989) and the 2003 values from ATUS we interpolated the U.S. household labor hours for 1990, 1995, and 2000. To estimate the Utah hours for the years preceding 2003 we assumed that the difference between the Utah and the U.S. household and parenting work hours for the 2003–2007 period held in the earlier years. We assumed that these Utah hours applied in all counties in the state. In turn, we obtained the total household labor hours per year for each county by multiplying the Utah household hours per person and by the numbers of women and men in each employment status in each county.

The total hours of household labor performed by Utahns increased steadily between 1990 and 2007 (Table 15). On a per worker basis, however, there was a decline in the household labor hours performed over this period. Consistent with the national trends, the amount of time women spent on housework and care work has declined in Utah. This decline is far greater for nonemployed women—full-time housewives and unemployed women—than for employed women whose annual household labor declined only slightly. This decline largely reflects substitution of store-bought goods and services for the unpaid services previously provided by family members as these market substitutes become more widely available and affordable.

Table 15. Total household labor hours

	1990	1995	2000	2003	2005	2007
Cache County	47,769,794	55,483,301	63,196,807	63,905,476	64,614,145	71,166,925
Davis County	119,794,094	137,561,067	155,328,040	175,812,870	176,310,159	191,729,031
Salt Lake County	501,724,871	560,713,185	619,701,499	611,236,412	634,922,657	683,664,093
Utah County	183,352,746	216,234,800	249,116,855	251,165,196	282,979,763	314,109,991
Washington County	36,220,885	51,555,653	66,890,421	76,830,660	86,770,900	95,871,174
Weber County	114,455,973	125,700,879	136,945,784	139,621,727	142,297,670	153,100,999
State of Utah	1,189,852,550	1,361,274,544	1,532,696,538	1,550,243,956	1,647,823,954	1,784,890,783

In the case of employed women, entry into the labor force tends to result in reduced hours of housework as families shift to preparing meals that require less time or eating out to a greater extent, cleaning house less frequently, placing their children in daycare, and so on. These changes indicate a shift in the locus of work from the household to the market and thus would be reflected as an increase in personal consumption expenditures. Indeed, other data sources, such as the Panel Study of Income Dynamics conducted by the Institute for Social Research at the University of Michigan (2010), also document this decline in hours of household labor performed by U.S. women over time (Blau et al. 2005). Household labor by employed Utah men increased slightly between 1990 and 2007, whereas nonemployed men have slightly reduced their hours of household labor over this period.

According to ATUS data for 2003–2007, employed women in Utah performed nearly identical hours of household labor as employed women in the U.S., whereas employed men in Utah did fewer hours compared to their counterparts in the nation (the Utah to U.S. hours ratio for men was 0.94). Nonemployed women and men in Utah performed more household hours relative to the national average (1.10 and 1.08 times more, respectively).

To calculate the value of household labor, consistent with other GPI studies we used the replacement cost approach and assigned the local wage rates for “maids and housekeeping cleaners” as the hourly wage rate for household labor. These wage rates yield a lower-bound estimate of the value of household labor, because this group of workers is paid relatively low-wage rates. In Utah, when adjusted for inflation, the hourly pay for this occupation declined slightly from $8 to $7 between 1990 and 2007 (2000 USD) (BLS 2010d).

The total value of household labor performed in the state steadily increased between 1990 and 2007 (Table 16). In 2007 an estimated 1,784,890,783 hours of household labor were performed in the state at $7 per hour. At a total value of $12.5 billion, this magnitude represents the largest positive adjustment to personal consumption expenditures in 2007. Further, to give an indication of the relative magnitude of the total monetary value of household labor performed in the state, we note that this magnitude amounted to 14% of Utah's GDP in 2007. This suggests a substantial contribution of unpaid household labor to the well-being of Utahns. That said, as a share of personal consumption expenditures the value of household labor declined from 38.9% in 1990 to 16.6% in 2007. This decline partly reflects increasing reliance on market substitutes to provide household labor services that were previously provided by family members and may not indicate an actual increase in total production in the economy. It also reflects expansion of our overall personal consumption. In per-capita terms as well, the value of household labor declined from $5,484 to $4,618 over this period.

Table 16. Total value of household labor in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$358.3	$399.4	$440.5	$443.5	$446.5	$497.1
Davis County	$863.7	$952.2	$1,040.7	$1,193.2	$1,170.7	$1,250.0
Salt Lake County	$4,053.9	$4,353.9	$4,654.0	$4,536.4	$4,863.5	$4,934.0
Utah County	$1,452.2	$1,642.8	$1,833.5	$1,784.1	$1,918.6	$2,316.5
Washington County	$294.5	$400.1	$505.7	$577.8	$649.9	$710.2
Weber County	$825.2	$871.4	$917.5	$931.2	$944.9	$998.1
State of Utah	$9,483.1	$10,420.2	$11,357.3	$11,360.3	$11,567.7	$12,466.6

VOLUNTEER WORK

Volunteer labor is another form of unpaid labor that is left out of consideration in the accounting of value of services in the GDP. Yet, volunteer labor is important for supplementing services performed by wage-workers and sometimes filling gaps in services that are provisioned through the market. Volunteer labor also builds and strengthens social ties in a community. GPI includes an estimate of the monetary value of services performed on a volunteer basis.

TRENDS IN VOLUNTEERISM IN UTAH

The *Volunteering in America* website provides volunteer hours per resident for 2002–2008 for Utah and the U.S. (Corporation for National and Community Service 2010; Grimm et al. 2007). On average, Utahns volunteered 2.3 times the national volunteer hours between 2002 and 2008. We extrapolated the Utah hours for 1990, 1995, and 2000 from the annual Utah to U.S. ratio of hours from 2002 to 2008. As Table 17 shows, Utahns perform far more volunteer labor than the average American. This performance ranks Utah the first in the nation in terms of volunteer work.

Table 17. Volunteer hours per resident

	1990	1995	2000	2003	2005	2007
UT Volunteer hour/resident	70.3	67.6	65.6	85.0	87.5	76.6
U.S. Volunteer hour/resident	30.4	29.2	28.4	37.6	36.3	34.8

In the absence of county-level data on volunteerism, we estimated the volunteer hours per resident in each county in a given year based on education levels in each county. The justification for estimating county-level hours using education level is provided by Boraas (2003), who found education level to be a key predictor of volunteer participation in the U.S. In making the education adjustment we followed the methodology of Bagstad and Shammin (2009). First, we estimated the total volunteer hours in each county by multiplying volunteer hours/resident in the state by the population of each education level (less than high-school education; high school; some college; college and above). Second, we estimated a weighted average education level in each county using the number of years of schooling as weights (for example, 10 years for less than high-school education, 12 years for high-school graduation, 14 years for some college education, 17 years for college and post-college degrees). Thus the average education level in the state or a county is a weighted average based on the following formula: (% of population over 25 with less than high-school degree*10) + (% population over 25 with high-school diploma*12) + (% population over 25 with some college*14) + (% population over 25 with college degree or more*17). We then expressed the education level in each county relative to the state average education level (i.e. county education level divided by the state education level). Third, we multiplied the number of total volunteer hours for each geography (step 1 above) by this education ratio to obtain education-weighted volunteer hours.

Value of Volunteer Work used in GPI

The Independent Sector website reports the national-level values of volunteer work per hour for each year going back to 1980 (Independent Sector 2010). The state-level data indicate that in 2007 the hourly value of volunteer work in Utah was 86% of the hourly value for the U.S. We used this ratio to extrapolate the hourly value of volunteer labor in Utah in previous years, which we assumed applied in each of the counties as well.

The total value of volunteer work is the product of education-adjusted total hours for each county and the state and the value of volunteer work per hour in the state. Table 18 shows that at the state level the total value of volunteer work more than doubled between 1990 and 2007.

Table 18. Total value of volunteer work in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$30.9	$34.7	$38.5	$49.3	$60.2	$58.6
Davis County	$86.5	$95.4	$104.3	$174.3	$181.7	$174.4
Salt Lake County	$364.1	$407.5	$450.8	$616.0	$666.9	$644.8
Utah County	$106.6	$128.9	$151.2	$235.9	$270.8	$257.9
Washington County	$23.3	$34.2	$45.2	$64.0	$82.8	$84.5
Weber County	$79.1	$87.4	$95.8	$120.0	$144.2	$136.5
State of Utah	$690.6	$874.8	$1,059.0	$1,501.2	$1,661.5	$1,596.3

COMMUTING

Commuting to work is one of the undesirable side effects of our employment and residential patterns. Commuting entails both direct and indirect costs. There are the direct costs of keeping a car on the road or paying for public transit, both of which are included in personal consumption expenditures; and the cost of buying a car is included in the "Cost of Consumer Durables," which we deducted from the GPI. The indirect costs involve time spent in traffic in order to get to one's job,which is an opportunity cost that reflects decline in well-being.

Trends in Commuting

According to the American Community Survey (2010), the average one-way commute time for Utahns increased from 18.9 minutes in 1990 to 21.4 minutes in 2007. Residents in Davis, Salt Lake, and Weber counties have the longest average commute (Table 19). Utah County had the largest increase in commute time between 1990 and 2007 of the counties included in this study. We assumed commuting miles to be 30% of vehicle miles traveled in each county. Data on vehicle miles traveled were available from UDOT (2010). Because there was a relatively small change in total commuting miles traveled per person (Table 20), the increase in commute time may be attributed to greater traffic delays and/or urban sprawl.

Table 19. Average one-way commute time per commuter (minutes)

	1990	2000	2005	2007
Cache County	16.4	16.8	16.1	17.8
Davis County	18.8	22.4	22.2	22.8
Salt Lake County	20.1	22.5	21.2	22.2
Utah County	17.1	18.8	18.6	20.5
Washington County	15.5	17.2	18.1	18.6
Weber County	19.4	21.6	20.3	22.3
State of Utah	18.9	21.3	20.5	21.4

Table 20. Average commuting miles traveled per commuter per year

	1990	1995	2000	2003	2005	2007
Cache County	2,302	2,302	2,590	2,537	2,640	2,699
Davis County	2,346	2,346	2,610	2,567	2,532	2,555
Salt Lake County	2,396	2,396	2,432	2,548	2,496	2,590
Utah County	2,248	2,248	2,437	2,388	2,387	2,235
Washington County	2,769	2,769	2,965	2,750	2,685	2,943
Weber County	2,131	2,131	2,294	2,177	2,166	2,221
State of Utah	2,827	2,827	3,007	2,979	2,959	2,981

Costs of Commuting used in Utah GPI

We estimated the total cost of commuting on the basis of three components: 1) Cost of using owner-operated vehicle in commuting; 2) time cost of commuting; and 3) passenger expenditures on public transit. For the Utah study, our estimates are based on the following methodology, which diverges from the one used most recently in the Ohio study (Bagstad and Shammin 2009):[7]

1) **Cost of commuting using owner-operated vehicle**: We multiplied the daily commuting miles per county (based on Table 20) by the mileage reimbursement rate used by the General Services Administration, expressed in 2000 dollars (General Services Administration 2010). Consistent with other U.S. GPI studies, we assumed commuting miles to be 30% of vehicle miles traveled in each county. The mileage reimbursement rate covers the fixed and variable costs of operating a private car (gas, insurance, expenses associated with wear and tear). We used the actual mileage rates for all years, except 1990, which we extrapolated.

2) **Cost of commuting time**: We estimated this indirect cost by multiplying the commute time (in hours) per commuter per year, the hourly wage, and the number of employed people in each county and the state each year. County- and state-level commute time data reported in Table 19 come from the American Community Survey of the Census Bureau. Commute distance is a function of total vehicle miles traveled as reported by the Utah Department of Transportation (Table 20). Following Talberth et al. (2007) and Bagstad and Shammin (2009), we assume that commuting may be viewed as part nuisance and part leisure and assigned an hourly wage that is 72% of the average hourly wages for each county and the state, as reported by the BLS (BLS 2010d). The product of county (or state) hourly wage and the county (or state) commute time per person provides the cost per commuter. By multiplying this magnitude by the number of employees in each county (or state) we obtain the estimate of total cost of commuting time in each county (and the state).

3) **Public transit spending**: The consumer expenditures on public transit fares come from the public transit agency passenger revenue data reported in on-line reports of various transit agencies in the state. We also obtained some

[7] The Ohio GPI study estimated the cost of using an owner-operated vehicle for commuting by implementing the methodology outlined by Anielski and Rowe (1999) and used expenditures by public transit systems (rather than passenger expenditures on transit fares) to estimate the cost of commuting via public transportation.

of them through requests for data. We have complete data for the counties served by the Utah Transit Authority (Davis, Weber, Salt Lake, Utah), Iron County, and Washington County (SunTran of St. George). Summit County and Cache County transit systems operate free of charge to passengers. Because the St. George (Washington County) public transit was formed in 2003, there were no fare revenues for the earlier years.[8]

Table 21. Total cost of commuting in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$89.8	$119.2	$141.7	$148.7	$164.5	$197.8
Davis County	$280.8	$379.2	$461.7	$460.2	$519.9	$602.6
Salt Lake County	$1,231.4	$1,627.8	$1,785.6	$1,657.3	$1,845.4	$2,183.2
Utah County	$346.9	$474.2	$594.9	$632.5	$691.8	$823.9
Washington County	$63.1	$111.9	$142.1	$163.0	$196.7	$255.0
Weber County	$231.4	$298.4	$340.8	$329.9	$343.9	$405.1
State of Utah	$2,845.6	$3,817.7	$4,462.1	$4,428.7	$4,890.3	$5,755.8

In our final estimates of total cost of commuting for the state (Table 21), we included the cost of public transit for riders, but we left out this category of spending from the county-level estimates because data for Weber, Davis, Salt Lake, and Utah counties are only available in the aggregate. Public transit expenditures (fares) account for less than 1% of total cost of commuting, assuming that the costs associated with commute time are primarily derived from driving.

VEHICLE CRASHES

Automobile accidents have both direct and indirect costs to society. Direct costs include property damage and healthcare expenses. Indirect costs include the value of lost life and lost wages associated with injury and death. GPI deducts these expenditures since accidents are a regrettable side effect of owning and driving vehicles, which undermines our well-being.

Vehicle Accident Trends in Utah

The Utah Division of Public Safety (UDPS) tracks crash statistics at the county level and publishes a crash report every year (UDPS 2000b, UDPS 2003b, UDPS 2005b, and UDPS 2007b). We derived the data presented in Table 22 from these reports. Data were available for the number of total crashes, fatal crashes, and crashes resulting in injury. In addition, the total number of fatalities and injuries were available from the UDPS. Total injury data were not available at the county level for 1990 and 1995. We estimated values for those years based on the percentage of total Utah crashes that occurred in each county during those years; therefore we assumed that the number of injuries per crash was the same across counties.

[8] This methodology of accounting for public transit costs produces much lower estimates than the methodology used in other US GPI studies that have included total expenditures of running the public transit system. In the calculations for Utah, if the public transit systems do not charge fares then there are no costs included and, even when there are fares, fare revenues are a fraction of the total expenditures of operating the public transit system.

There has been a steady decline in crashes resulting in injury or death over the past 40 years due to traffic safety programs, seatbelt usage, aggressive media and enforcement programs targeting driver behavior, improved roadways, improved vehicle safety, and advancements in emergency response (UDPS 2007b). Utah's traffic fatality rate (fatalities per 100 million miles traveled) has been lower than the U.S. rate since 2001 (U.S. data from National Highway Traffic Safety Administration as reported in UPDS 2007b). In 2007, the death rate was 1.11 deaths per 100 million miles traveled compared to the U.S. rate of 1.36. Both Utah and U.S. statistics show a steady decrease in death rates since 1988. Nonetheless, total vehicle crashes in Utah reached a low of 50,389 in 2003, after which they rose steadily to 61,245 crashes in 2007 (Table 22).

Table 22. Crash statistics summary for Utah and selected counties between 1990 and 2007

	1990	1995	2000	2003	2005	2007
TOTAL CRASHES						
Cache County	2,019	2,357	1,985	2,166	1,972	2,219
Davis County	3,851	4,688	4,669	4,047	4,322	5,410
Salt Lake County	25,563	26,124	23,319	21,777	23,887	26,883
Utah County	7,134	8,603	8,044	7,336	8,697	9,530
Washington County	1,276	1,545	1,599	2,103	2,544	2,435
Weber County	4,399	4,698	4,583	4,558	4,550	4,870
State of Utah	52,691	57,644	53,151	50,389	54,938	61,245
TOTAL FATALITIES						
Cache County	13	4	17	7	6	6
Davis County	17	21	12	16	8	19
Salt Lake County	59	105	88	51	63	54
Utah County	24	38	43	38	21	24
Washington County	9	9	16	23	14	22
Weber County	21	26	22	10	20	25
State of Utah	272	325	373	309	282	299
TOTAL INJURIES						
Cache County	790	1,159	957	1,004	902	892
Davis County	1,506	2,305	2,160	2,191	2,287	2,550
Salt Lake County	9,998	12,845	14,224	12,068	12,685	11,441
Utah County	2,790	4,230	4,566	4,323	4,654	4,621
Washington County	499	760	839	1,274	1,390	1,397
Weber County	1,720	2,310	2,498	2,693	2,534	2,371
State of Utah	20,608	28,343	30,086	28,352	29,221	27,420

Cost of Vehicle Crashes Used in Utah GPI

We used the data on total fatalities, injuries, and crashes involving property damage (all crashes reported in in the Utah Crash Summary involve at least $1,000 of property damage) described above to calculate the total costs associated with crashes in Utah. The National Safety Council's annual injury fact report (NSC 2003) estimates the cost of each vehicle crash fatality to be $1,014,000, of disabling injuries to be $50,800, and of property damage crashes to be $6,640 in 2000 USD. These values were also used in the GPI studies for Vermont and Ohio (Costanza et al. 2004; Bagstad and Shammin 2009).

Although the total costs associated with vehicle crashes in Utah increased from $1.7 billion in 1990 to $2.1 billion in 2007 (Table 23), the per-capita cost in Utah decreased steadily from $971 in 1995 to $782 in 2007. Salt Lake and Weber counties consistently had the largest per-capita costs associated with vehicle accidents, whereas Davis and Utah counties consistently had the lowest per-capita costs (Table 24).

Table 23. Total cost of vehicle crashes in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$67.0	$78.7	$79.5	$72.7	$65.2	$66.3
Davis County	$119.8	$170.1	$153.2	$154.8	$153.2	$185.2
Salt Lake County	$739.0	$935.2	$968.9	$810.7	$868.5	$815.9
Utah County	$214.1	$311.5	$330.1	$307.8	$316.0	$323.0
Washington County	$43.2	$58.2	$69.9	$102.6	$102.1	$110.0
Weber County	$138.5	$175.6	$180.2	$177.5	$179.7	$178.8
State of Utah	$1,679.6	$2,160.6	$2,269.2	$2,096.2	$2,142.5	$2,110.6

Table 24. Cost of vehicle accidents, per capita (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$950	$958	$865	$740	$629	$608
Davis County	$635	$787	$638	$591	$551	$626
Salt Lake County	$1,015	$1,130	$1,073	$862	$888	$801
Utah County	$805	$1,004	$888	$727	$693	$644
Washington County	$882	$798	$767	$935	$803	$781
Weber County	$873	$986	$912	$862	$841	$810
State of Utah	$971	$1,083	$1,010	$868	$841	$782

CRIME

The GPI subtracts the expenditures on crime prevention and the direct costs of crime to individuals because these expenditures either prevent the deterioration of well-being or compensate for its decline. The cost of crime is borne by potential or actual victims of crime, and government and business in the form of police services and security guards. The latter two expenditures are left out of the calculation of the cost of crime in GPI, because spending on public safety is defensive spending that the GPI leaves out. And the business expenditures on security are not included in the calculation because these are intermediate costs that end up being part of the price of consumer goods and services, which already are accounted for in personal consumption spending.

TRENDS IN CRIME IN UTAH

We obtained county level crime data from U.S.A. Counties Database of the Census Bureau for 1990 and 1995 (USCB 2010b) and the Utah Crime Reports for more recent years (UDPS 2000, UDPS 2003, UDPS 2005, UDPS 2007) Crime categories used in the analysis include both violent crimes (murders and manslaughters, rapes, robberies, aggravated assault) and property crimes (burglaries, larceny theft, motor vehicle theft). 1995 was the peak year for the number of incidents of all crimes, except for rape, which continued to rise until 2005 (Table 25).

Table 25. Utah crime trend summary

	1990	1995	2000	2003	2005	2007
MURDERS AND MANSLAUGHTERS						
Cache County	0	0	0	1	2	0
Davis County	1	1	3	10	3	1
Salt Lake County	33	42	31	29	30	43
Utah County	2	2	2	3	5	2
Washington County	1	1	1	2	2	2
Weber County	3	6	8	4	7	4
State of Utah	50	73	52	57	55	55
RAPES						
Cache County	14	16	27	20	33	22
Davis County	49	49	73	88	94	78
Salt Lake County	380	477	412	451	455	482
Utah County	72	79	100	103	146	91
Washington County	10	21	32	15	28	33
Weber County	67	66	114	84	74	86
State of Utah	645	796	856	877	937	927
ROBBERIES						
Cache County	1	7	7	1	7	6
Davis County	40	53	25	50	48	40

	1990	1995	2000	2003	2005	2007
ROBBERIES (CONT)						
Salt Lake County	803	990	904	973	778	1,060
Utah County	29	45	54	51	61	90
Washington County	2	7	5	1	14	19
Weber County	80	137	161	122	154	202
State of Utah	976	1,273	1,190	1,241	1,100	1,448
AGGRAVATED ASSAULTS						
Cache County	24	41	42	36	29	35
Davis County	199	183	246	232	187	180
Salt Lake County	2,015	2,295	1,881	2,099	2,127	2,379
Utah County	245	314	192	208	263	228
Washington County	56	118	202	125	240	173
Weber County	338	490	354	402	299	452
State of Utah	3,190	4,011	3,254	3,479	3,515	3,891
PROPERTY CRIMES						
Cache County	2,118	2,819	2,196	1,824	1,973	1,464
Davis County	6,569	6,266	6,414	6,883	6,591	6,563
Salt Lake County	54,093	62,644	45,943	53,762	53,175	50,072
Utah County	10,217	13,194	12,201	13,418	13,296	12,331
Washington County	1,453	2,728	1,918	1,751	2,655	3,315
Weber County	8,870	10,145	8,955	9,244	8,842	9,552
State of Utah	91,076	108,552	87,056	96,154	95,002	92,840

Cost of Crime used in Utah GPI

The total cost estimates by type of crime are available for Utah for robberies, burglaries, larceny-theft, and auto theft in 2000 (UDPS 2000). The Utah Department of Public Safety reports each of these costs as the total value of the goods stolen. Dividing these dollar values by the number of crimes in 2000 provides an average cost per crime for Utah households in 2000, which we used for all years in calculating the total cost of crime (i.e., the average cost for each crime in 2000 multiplied by the number of crimes in each geography in each year).

In past GPI studies only the cost of property crimes was included, which made the estimates of the cost of crime inherently quite conservative. In the Utah study, we also estimate victim costs of murders, aggravated assaults, rapes, and robberies. The valuation of human life is quite controversial, with several alternative valuation methods available (Viscusi 2000). One way to include the cost of murder in crime cost estimates would be to use the same value as the cost of traffic fatalities from car crashes. Because the GPI already assigns costs to one type of fatality, the same method could be used for the cost of murder. Applying similar costs to victims of traffic fatalities and murders at least gives a conservative estimate of the cost to the victims of one type of violent crime. Hence, we estimated the cost per murder or manslaughter as the value of a statistical life used in the cost of vehicle crashes calculation ($1,040,000 in 2000).

The victim cost of rape is based on Miller et al. (1996) and adjusted for inflation to reflect the 2000 cost for the crime. Almost all of this cost is the intangible cost (nonmonetary losses and lost quality of life) of the crime. [9] The victim costs of aggravated assault and robbery are based on Rajkumar and French (1997), which we also expressed in 2000 dollars.[10] In each case the victim cost includes sum of medical expenses, lost wages, the value of property damage, and the risk of homicide cost, which is much higher in the case of aggravated assault. The cost of domestic violence with injuries does not appear as a separate crime category in our estimation, because the state does not report the incidents of this crime in a comparable manner to other nonproperty crimes. Some of the incidents of domestic violence are likely to be counted as aggravated assault or homicide incidents. However, if they are not recorded in other crime categories, domestic violence incidents are not counted in the crime statistics, which would lead to underestimation of the cost of crime.

In addition to the direct cost of crime, there are household expenditures to prevent crime. We compiled the ESRI consumer spending data on security systems and safe deposit boxes at the county and state level.[11] These total expenditure values for 2008 were then used to estimate the total costs in each of the relevant years in the Utah study by using the rate of growth of national expenditures on locks, safe deposits and burglar alarms between 1989 and 2008. We estimated the annual rate of growth on these two categories of spending based on Anielski and Rowe (1999), who assumed a 2.8% increase in national spending on locks and safe deposits over the 1950–1994 period, and the 7.25% annual growth of spending on residential burglar alarms between 1989 and 1997. These data were then converted to 2000 dollars and used to build a national time series on the total cost of crime prevention expenditures. We used the annual percentage changes in the national expenditures on this total category to generate the time series going back to 1989 for all Utah counties (starting from the 2008 ESRI values for each county).

As an additional crime prevention expenditure, we estimated the cost of carrying a concealed firearm as a lower-bound estimate for the personal cost of bearing firearms for self-protection. We obtained the number of concealed firearm permits by county for the 1990–2007 period from the Bureau of Criminal Identification of the Utah Department of Public Safety (UDPS 2010b). There has been an enormous increase in the concealed firearms permits acquired by residents in recent years. In 1990 only 195 permits were issued to Utah residents. By 1995 the number jumped to 3,755 and by 2007 it had reached 73,683 permits. Our cost estimate is based on the cost for a 10-year time frame, and relies on the number of concealed firearm permits in each county multiplied by a lower-bound estimate of the cost of carrying a concealed firearm. We estimated this cost on the basis of the purchase price of a handgun, the average cost of the training class, permit cost, and the permit renewal fee. Accordingly, in 2010, the average annual cost of carrying a concealed firearm (based on a 10-year time frame) was $55/yr.

The total cost of crime is the sum of the direct expenditures that result from crime and the crime prevention expenditures (Table 26). The total cost of crime in the state steadily increased after 2000. Although direct cost of

[9] Miller et al. (1996) estimate the cost at $87,000 in 1993, $81,400 of which was the intangible component of the cost.

[10] Rajkumar and French (1997) estimated the cost of aggravated assault at $50,743 in 1992, of which $46,713 was the victim cost of the crime. They estimated the cost of robbery in 1992 as $21,890, of which $17,454 was borne per victim. While the Utah Department of Public Safety reports the total value of the goods stolen in robberies, these figures underestimate the total victim cost of a robbery, which includes an estimate based on the probability that a robbery could result in a homicide.

[11] The consumer spending categories included are: property management and security for owned dwellings; management and upkeep fees for security for owned dwellings; safe deposit box rentals; home security system services.

crime constitutes the larger component of the total cost of crime, defensive (indirect) expenditures rose faster than the direct cost of crime over the 1990–2007 period. In 1990 indirect costs accounted for 4% of total cost of crime in the state. By 2007 they reached 18% of total crime costs.

Table 26. Total cost of crime in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$6.5	$8.5	$9.4	$7.2	$7.5	$8.4
Davis County	$31.0	$30.9	$36.4	$30.8	$36.2	$36.0
Salt Lake County	$218.7	$257.0	$228.8	$256.3	$257.9	$267.5
Utah County	$39.8	$48.2	$43.8	$46.8	$53.2	$48.5
Washington County	$8.0	$14.4	$19.7	$12.5	$22.5	$19.6
Weber County	$39.0	$47.7	$42.8	$47.1	$37.5	$53.0
State of Utah	$371.3	$445.4	$420.7	$445.8	$460.3	$490.2

FAMILY BREAKDOWN

National GPI studies have estimated the cost of family breakdown on the basis of two proxies: the cost of divorce to the adults and children involved in divorce and the cost of television (TV) watching in families with children.

GPI studies identify divorce as one consequence of the stress and anxiety associated with contemporary social life. These stresses often emanate from trying to keep up with consumption patterns by working harder and sometimes taking out debt to sustain standards of living. The resultant strains compromise quality time in families and may lead to the fraying of family bonds. In the GDP methodology, divorce adds to the GDP—in the form of expenditures to set up separate households, lawyers' and counseling fees. GPI methodology, on the other hand, treats family breakup as an undesirable, which reduces well-being of the individuals and children involved in divorce. While there is some scholarship that suggests there is an upside to divorce (Ahrons 1995) and that children benefit from not staying in high-conflict marriages (Amato, Spencer Loomis, and Booth 1995), most of the studies show that divorce is not good for children (McLanahan and Sandefur 1994; Wolfinger 2005).

Research into the effects of TV watching continues decades after this medium created a common household activity. Many critics have focused on its adverse effects on social and family life and individual health. Robert Putnam (1995; 2000) singled out TV watching as the key culprit in the decline of civic engagement in the U.S. Putnam interpreted the growth of TV viewing hours as "privatizing" or "individualizing" the use of leisure time and thereby undermining opportunities to build social relationships. Recent research shows harmful effects of television on parent-child interactions and the harmful effects of adult background television on infant and toddler behavior (Kirkorian et al. 2009). TV watching has also been linked to obesity, which is a rising epidemic in U.S. society. The health effects of obesity, however, would be captured in the health care spending to address its effects, albeit this spending would arise with a lag, and, unless it is deducted, it would be counted as a net positive in the GPI.

To estimate the cost of TV watching, in the Utah GPI we focus on family households, which refer to families with children less than 18 years of age. Past U.S. GPI studies assumed that in family households all hours spent watching TV are excessive, which reflects the concern that TV watching in these households is replacing other family activities that strengthen family ties and values. The concern reflected in this particular component of GPI is the likely contribution of TV watching to family integrity, even if one could make the case about educational gains associated with some kinds of TV programming or the family bonding that may occur while watching a program together. Partly acknowledging this possibility, in the Utah GPI study we assumed that TV watching hours in excess of 2 hours per day in family households are excessive.

Current potential variants of TV watching could be time spent playing video games, internet surfing, or spending time at on-line social network sites, each of which tend to be individual activities that detract from communication and interaction as a family. The effects of increased screen time enabled by new technology are subject to ongoing research and debate, with concerns raised about the negative effects of distraction and multitasking they generate. In the Utah GPI study we do not factor in the hours spent on these activities using electronic gadgets. Arguably, time spent on these more recent engagements constitute additional hours of screen time in households with children, rather than substituting for the TV-watching hours. Thus, by only tracking time spent watching TV in family households we provide a conservative estimate of the overall screen time in such individual engagements that take away from family activities.

Divorce Trends and Costs

The total number of divorces in Utah increased until 2005 (Utah Department of Health 2010; CDC 2010b) (Table 27). Utah's divorce rate, however, which expresses the number of divorces as a share of population, declined steadily from 5.1 per 1,000 population to 3.6 per 1,000 population between 1990 and 2007 (CDC 2010b). The divorce statistics for the state and its counties are available for 2000 onward through the state vital statistics records, but they are not available for 1990 and 1995. For these years, we estimated the number of divorces in each county and the state based on the divorce rate in the state and the county population. The number of children affected by divorce for each county and the state was available for 2000–2007 (Utah Department of Health 2010); and for 1990 and 1995, we estimated this number for each county based on the number of children affected by divorce in the state. We divided that number by the number of divorces in the state and then multiplied it by the number of divorces in each county. Thus, the county figures on numbers of children affected are derived from the state numbers.

Table 27. Divorce trend in Utah (numbers)

	1990	1995	2000	2003	2005	2007
Cache County	360	361	322	318	253	317
Davis County	961	951	1,091	1,141	1,007	757
Salt Lake County	3,714	3,640	3,942	3,705	4,115	3,922
Utah County	1,355	1,365	1,220	1,182	1,455	1,430
Washington County	250	321	519	512	576	567
Weber County	809	784	1,060	1,047	997	929
State of Utah	8,819	8,779	9,604	9,517	10,003	9,509

Our estimates of the cost of divorce are those directly incurred by the persons involved in divorce. For adults, the cost includes goods and services, such as legal fees and the cost of setting up separate households, which are counted in personal consumption spending. This spending is deducted from GPI.

As with many of the GPI components, there are public costs in addition to personal costs associated with divorce. Although we do not include the public costs they provide a useful benchmark in estimating the cost of family fragmentation to society. Scafidi (2008) estimated the cost of divorce nationally and by state, accounting for costs to the legal system and in increased government expenditures often used to support single-parent families as part of the social safety net. These costs amounted to $112 billion nationally in 2006. Scafidi estimated the state and local taxpayer costs in Utah to be $276 million in 2006.

We obtained the direct cost per divorce to adults in Utah from Schramm (2006), who estimated total direct costs for 9,735 divorces in Utah in 2001 as $116,851,736 (or $12,003 per divorce), and expressed it in 2000 dollars as $11,671. Based on national level estimates in Anielski and Rowe (1999), the cost per child affected by divorce was $13,380 in 2000 dollars. The total cost of divorce in each county, in turn, is the cost for adults (cost per divorce in Utah multiplied by the number of divorces in each county) plus the cost to children affected by divorce (cost per divorce in the U.S. multiplied by the number of children affected by divorce in each county).

TV Watching

The average hours per day U.S. households spent watching TV increased from 6 hours and 53 minutes to 8 hours and 14 minutes between 1990 and 2007, according to the TV Bureau of Advertising (2010). Expressed in terms of hours, these translate into 6.88 hours and 8.23 hours, respectively (Table 28). We adjusted this number to reflect the TV hours in Utah, by comparing the U.S. and Utah hours of TV watching reported in the American Time Use Survey for 2003–2007. According to ATUS, Utahns watched 18.3% less TV than the U.S. average in 2003–2007. We applied this individual level differential to the national hours of TV watching per household per day to estimate the household level hours per day of TV watching in Utah. Thus between 1990 and 2007, Utah families increased their TV viewing hours by slightly more than an hour per day, from 5.6 hours to 6.7 hours, or by 20% (Table 28).

Table 28. TV watching statistics

	1990	1995	2000	2003	2005	2007
U.S. hours/day-household (hours)	6.88	7.28	7.58	7.97	8.18	8.23
UT % deviation from U.S.	-0.183	-0.183	-0.183	-0.183	-0.183	-0.183
UT hours/day-household UT	5.62	5.95	6.19	6.51	6.68	6.72

To estimate the monetary cost of time spent watching TV in family households, we used similar methods as in earlier GPI studies (Anielski and Rowe 1999; Bagstad and Ceroni 2007). Accordingly, the total cost of TV watching is the product of the number of excessive hours of TV watching per year in family households who own a television and a value per hour. Excessive hours refer to more than two hours per day. We assumed that 98% of Utah households own TVs, which is the same as the U.S. level. Following Anielski and Rowe (1999), we assumed each hour of TV watching was worth $0.54 in 2000 dollars. This per-hour cost of TV watching is very low, which indicates the difficulty of attaching a monetary value to each hour of family bonding activities that are foregone by watching TV. This conservative (lower-bound) unit cost needs refinement based on future scholarship and data availability.

Cost of Family Breakdown used in Utah GPI

The total cost of family breakdown, expressed as the sum of cost of divorce and cost of TV watching, steadily increased in Utah over the 1990–2007 period (Table 29). This increase was due to the rise in cost of TV watching, which rose by 57%, whereas total cost of divorce declined by 9% over this period. The per-capita costs of family breakdown declined, however, due to faster population growth.

Table 29. Total cost of family breakdown in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$17.5	$18.0	$18.3	$18.9	$18.1	$21.0
Davis County	$49.1	$50.2	$57.4	$64.6	$58.5	$54.5
Salt Lake County	$184.1	$183.2	$200.2	$194.2	$208.9	$206.3
Utah County	$65.0	$68.6	$71.4	$73.0	$88.8	$90.3
Washington County	$11.7	$15.2	$22.7	$24.4	$28.2	$28.9
Weber County	$39.9	$39.8	$49.5	$50.5	$50.9	$48.5
State of Utah	$435.9	$445.2	$497.2	$515.6	$538.8	$537.7

Leisure Time Lost

Based on studies that indicate a rise in overwork and decline in leisure time in the U.S., GPI studies aim to estimate the monetary value of the loss or gain in leisure that we experience. We updated the methodology used in previous GPI studies by relying on state-level data for working hours and identifying a different set of premises. Following Leete-Guy and Schor (1992) and Schor (1991), we assumed that the question of loss of leisure could be most appropriately assessed by focusing on workers who worked full-time, year-round, rather than those in the labor force. Fulltime, full-year workers are those who spent at least 35 hours per week and 50 weeks per year in paid employment.

Trends in Leisure Time

Our assessment of underemployment trends in Utah indicates that the fully-employed workers experience overwork, whereas the underemployed work fewer hours and enjoy forced leisure. As noted in the discussion of underemployment trends, based on the March CPS, between 1990 and 2007, the annual hours of workers who were employed full-time, year-round has increased from 2,263 to 2,297 hours per worker (CEPR 2010). We assumed that fully-employed workers performed the same number of household hours as employed workers. When hours performed in the labor market are added to unpaid household labor hours, the fully employed workers in Utah performed between 3,014 and 3,069 hours of work per year during the study period. Assuming we each have 15 hours per day or 5,475 hours per year discretionary hours for work and play, we estimate the number of leisure hours per fully employed Utah worker. This magnitude ranges between 2,400 and 2,460 hours per year during the study period (i.e., 5,475 discretionary hours minus total hours of work). To assess the change in leisure hours over time, we identified a benchmark value for leisure hours per year. As in previous GPI studies, we picked 1969 as the peak year for leisure hours in recent U.S. history, based on the working hours estimates of Leete-Guy and Schor (1992). According to their study, average annual working hours for fully-employed workers in the U.S. was at its lowest level in 1969. Thus, compared to the peak leisure hours experienced by the average fully employed worker in the U.S. in 1969 (of 2800 hours), the fully-employed worker in Utah had 339 hours less leisure time in 1990 and this leisure gap widened over the study period to 369 hours.

COST OF LEISURE TIME LOST USED IN UTAH GPI

We used the hourly wage rate for each county and the state from the Bureau of Labor Statistics (in 2000 dollars) (BLS 2010d). This wage rate was adjusted upward by 1.28, based on the assumption made in the Ohio GPI study that each hour of leisure is worth more than each hour of labor market work (Bagstad and Shammin 2009). This scaling up is the counterpart of scaling down the hourly wage rate used in estimating the time cost of commuting (because commuting may be partly enjoyable).

We arrived at the value of lost leisure hours in each county by multiplying the lost leisure hours per fully employed worker by the leisure-adjusted real wage per hour and by the number of fully employed workers in the county. Valued at market wage rates, the value of lost leisure hours for Utah's fully employed workers nearly doubled from $3.2 billion to $6.1 billion over this period (Table 30). For the average Utahn, this amounted to a reduction in genuine progress by $2,255 in 2007, up from $1,860 in 1990.

Table 30. Total cost of the loss of leisure time in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$111.6	$171.0	$183.5	$177.5	$191.9	$234.9
Davis County	$323.3	$483.6	$506.5	$475.4	$523.3	$614.3
Salt Lake County	$1,555.4	$2,306.8	$2,267.5	$1,988.1	$2,159.8	$2,654.7
Utah County	$433.5	$671.4	$750.6	$686.5	$765.1	$928.7
Washington County	$64.6	$134.4	$149.1	$154.2	$186.3	$257.3
Weber County	$301.9	$433.2	$433.6	$393.9	$413.1	$489.3
State of Utah	$3,215.9	$4,828.6	$5,010.7	$4,604.3	$4,992.2	$6,087.2

WATER POLLUTION

Clean water in our streams, lakes, rivers, bays and oceans provides ecological services in the form of clean drinking water, healthy fisheries, safe and enjoyable recreation, aesthetics, increased property values, and healthy aquatic life. When water becomes polluted through excess nutrients, sediments, heavy metals, or toxins, there are many costs that result — increased costs of treating drinking water, losses to tourism, loss of recreation, costs associated with the loss of fisheries, reduced property values and the loss of aquatic life and habitats that depend on clean water.

Utah designates beneficial uses to all of the surface waters in the state, according to the classes outlined in Table 31 as required by the Clean Water Act. Under section 303(d) of the Clean Water Act, each state must submit an annual list to the EPA identifying waters that are not achieving water quality standards in spite of efforts to reduce pollution to streams and lakes. The waters identified on this list are known as impaired waters. They are described in each state's bi-annual 303(b) assessment report to Congress.

Table 31. Summary of beneficial use designations for waters of Utah (Rule Code R317-2)

Class	Description
1	Protected for use as a raw water source for domestic water systems.
1C	Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water.
2	Protected for recreational use and aesthetics.
2A	Protected for primary contact recreation such as swimming.
2B	Protected for secondary contact recreation such as boating, wading, or similar uses.
3	Protected for use by aquatic wildlife.
3A	Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
3B	Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
3C	Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
3D	Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.
3E	Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.
4	Protected for agricultural uses including irrigation of crops and stock watering.
5	The Great Salt Lake. Protected for primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary aquatic organisms in their food chain, and mineral extraction.

Recreational classifications are for water bodies that are suitable or intended to be made suitable for primary and secondary contact recreation. Secondary contact recreation (2B) refers to uses where full immersion does not occur, such as boating and wading. Waters designated for secondary contact recreation are required to maintain low bacteria counts in order to maintain healthy conditions for recreational users. Waters designated for warm water game fish and associated food chains (3B) are required to exhibit appropriate levels of dissolved oxygen (DO), temperature, pH, and other parameters for warm water aquatic life support. Waters designated for use by waterfowl, shorebirds, and other water-oriented wildlife (3D) not included in classes 3A or 3B (including the necessary aquatic organisms in their food chain) are required to exhibit physical, chemical, and biological characteristics supportive of all levels of the food chain. Waters designated as agricultural water supply (4) (including irrigation and livestock watering) are required to be suitable for the irrigation of crops or as water for livestock. They also are required to meet general surface water quality criteria for total dissolved solids (TDS) and various metals such as lead and cadmium.

Trends in Water Quality in Utah

Since the early 1980s, the quality of fresh waters in the U.S. and Utah has improved in large part due to the widespread implementation of secondary and tertiary wastewater treatment systems as required under the Clean Water Act (EPA 2000). Remaining point sources of pollution are primarily related to monetary and regulatory barriers, such as inadequate funding for wastewater treatment in small communities and the need for TMDL (total maximum daily load) studies to be completed under the Clean Water Act prior to regulation of some pollutants. *Nonpoint source* pollution has become the primary source of impairment in most streams, lakes, and reservoirs in Utah. Unlike point-source pollution, in which the source is identifiable and thus controllable, nonpoint source pollution is an aggregation of pollution that comes, often inadvertently, from residents, farmers, and businesses.

We compiled impairment status for rivers (miles) and lakes (acres) from individual 303(b) reports for the years 1996, 1998, 2000, 2002, 2004, and 2006. Impairment status by beneficial use was available as a map Geographic Information System (GIS) for 2006 from the Utah Division of Water Quality (UDWQ 2009). We intersected this map with a county layer using GIS software (ArcGIS) to determine impairment for all rivers and lakes for each of the beneficial uses that Utah designates for water bodies. In addition, beneficial use specific impairment was available at the state scale for 1996, 2000, 2002, 2004, and 2006. In 1990, too few waters had been assessed to be representative of the state.

Weber County has the largest percentage of lakes impaired due to impairment of Pineview Reservoir, the largest lake in the county. Similarly, the impairment in Utah County consists entirely of impairments to Utah Lake, which makes up 26% of the lake area assessed in the state. Across the state from 1990 through 2006, aquatic uses (3A, 3B, and 3D) were the most frequently impaired use on lakes. In 2006, a jump in impairment of agricultural uses was associated with high total dissolved solids (salts) in Utah Lake. Streams and rivers have primarily been impaired for recreational uses followed by aquatic uses and agricultural uses (UDWQ 1995, UDWQ 1997, UDWQ 2001, UDWQ 2003, UDWQ 2005, and UDWQ 2007; Table 32).

Table 32. Water Quality Impairment Trends by Beneficial Use in Utah

	Year	Drinking Water (1)	Recreation (2)	Cold-water fish (3A)	Warm-water fish (3B)	Cold and warm water fish (3A and 3B)	Ag Uses (4)
WATERSHED ACRES IN 2006							
Cache County	2006	0%	0%	13%	11%	12%	1%
Davis County	2006	0%	0%	0%	10%	1%	1%
Salt Lake County	2006	7%	5%	24%	2%	15%	2%
Utah County	2006	3%	3%	6%	0%	4%	2%
Washington County	2006	0%	0%	0%	0%	4%	16%
Weber County	2006	0%	0%	0%	0%	0%	0%
State of Utah	2006	1%	0%	15%	1%	10%	8%
LAKE ACRES IMPAIRED IN UTAH							
State of Utah	1996	0%	1%			38%	0%
State of Utah	2000	0%	1%			30%	0%
State of Utah	2002	0%	0%			31%	0%
State of Utah	2006	0%	0%			32%	26%
RIVER MILES IMPAIRED IN UTAH							
State of Utah	1996	0%	2%			26%	15%
State of Utah	2000	2%	2%			16%	17%
State of Utah	2002	1%	54%			18%	15%
State of Utah	2004	1%	6%			15%	14%
State of Utah	2006	1%	30%			19%	14%

COSTS OF WATER POLLUTION USED IN GPI

We summarized and interpolated the data reported in 303(b) reports to obtain an estimated percent of all waters impaired in each county across time for each of the four primary designated uses in Utah (drinking water, recreation, aquatic uses, and agriculture). We obtained the percent of rivers and lakes impaired for each beneficial use from the 2006 detailed impairment dataset summarized by county (UDWQ 2007). We used the 2006 303(b) report to represent impairments in 2007. Likewise, we used the 2004 report to represent 2005, the 2002 303(b) to represent 2003, and the 1996 report to represent 1995 and 1990 (because data prior to 1996 were not available).

We derived per-capita values of beneficial uses from total values for the U.S. reported in Freeman (1982), converted them to 2000 USD, and divided by the population in the U.S. in 2000. The original values from Freeman and their per-capita value counterpart in 2000 USD are presented in Table 33. These values are quite dated but no Utah specific value data were available for water quality. The Utah Division of Water Quality is currently developing a cost-benefit analysis of implementing nutrient criteria. This study, when completed, should provide a better value of beneficial uses of Utah's waters, as well as the loss in value associated with water quality degradation.

Table 33. Summary of values associated with beneficial uses for the U.S.

Beneficial use	Original value (Freeman 1982)	Per-capita value (2000 USD)
Drinking water	$1,300,000,000	$12.20
Boating recreation	$1,500,000,000	$14.07
Freshwater fishing	$1,000,000,000	$9.38
Total	$3,800,000,000	$35.65

We calculated the total value associated with beneficial uses for Utah by multiplying the per-capita U.S. value by the Utah population. We assumed that the value of fishing was spread equally between rivers and lakes in Utah. We calculated the county-level cost of water pollution as the percent of assessment units (a sub-watershed that includes a group of lakes, rivers, and streams) in a given county impaired for each beneficial use multiplied by the total value associated with that beneficial use for Utah. The total costs associated with water quality impairments in Utah have fluctuated as water bodies are included and excluded from the impaired waters list as a result of changes in water quality standards developed by the Utah Water Quality Board in response to changing science and recommendations from EPA; natural variability in water quality data due to variations in climate, hydrology, biological processes; and changes in classification of waters. Salt Lake County has the largest total cost for impairments whereas Davis County has the lowest total cost for impairments (Table 34). Most of the costs are associated with impaired aquatic life uses (3A and 3B).

Table 34. Costs associated with water quality impairments in Utah

	1990	1995	2000	2003	2005	2007
IMPAIRMENTS TO DRINKING WATER (CLASS 1)						
Cache County	$-	$-	$-	$-	$-	$-
Davis County	$-	$-	$-	$-	$-	$-
Salt Lake County	$-	$-	$2,325,118	$1,249,438	$1,534,696	$835,141
Utah County	$-	$-	$364,045	$213,736	$271,933	$156,215
Washington County	$-	$-	$12,958	$8,053	$11,013	$6,378
Weber County	$-	$-	$-	$-	$-	$-
State of Utah	$-	$-	$616,795	$341,822	$426,002	$235,873
IMPAIRMENTS TO RECREATIONAL USES (CLASS 2)						
Cache County	$-	$-	$-	$-	$-	$-
Davis County	$-	$-	$-	$-	$-	$-
Salt Lake County	$43,511	$43,511	$43,511	$1,232,098	$138,206	$686,736
Utah County	$11,747	$11,747	$11,747	$332,642	$37,313	$185,405
Washington County	$-	$-	$-	$-	$-	$-
Weber County	$-	$-	$-	$-	$-	$-
State of Utah	$56,370	$56,370	$56,370	$1,596,230	$179,051	$889,693
IMPAIRMENTS TO AQUATIC LIFE USES (CLASS 3)						
Cache County	$120,907	$126,184	$281,541	$302,488	$81,171	$102,735
Davis County	$18,211	$18,211	$11,538	$12,677	$10,413	$13,082
Salt Lake County	$2,699,182	$2,931,463	$627,939	$689,963	$566,701	$711,992
Utah County	$760,593	$865,050	$958,717	$1,087,763	$1,147,470	$1,273,982
Washington County	$169,386	$233,206	$72,860	$215,316	$240,297	$193,482
Weber County	$549,428	$616,675	$441,467	$460,108	$477,544	$986,809
State of Utah	$3,190,786	$3,423,979	$2,754,266	$3,013,834	$2,743,793	$3,223,453
ALL IMPAIRMENTS						
Cache County	$120,907	$126,184	$281,541	$302,488	$81,171	$102,735
Davis County	$18,211	$18,211	$11,538	$12,677	$10,413	$13,082
Salt Lake County	$2,742,693	$2,974,974	$2,996,568	$3,171,499	$2,239,602	$2,233,870
Utah County	$772,340	$876,797	$1,334,509	$1,634,141	$1,456,716	$1,615,602
Washington County	$169,386	$233,206	$85,818	$223,369	$251,310	$199,860
Weber County	$549,428	$616,675	$441,467	$460,108	$477,544	$986,809
State of Utah	$3,247,156	$3,480,350	$3,427,431	$4,951,886	$3,348,846	$4,349,020

AIR POLLUTION

The GPI deducts the cost to society associated with air pollution. The largest costs of air pollution are related to impacts on human health, and include premature mortality, increased frequency of illnesses, and an overall reduction in human health primarily related to tropospheric ozone and fine particulate matter ($PM_{2.5}$). Poor air quality has been linked to decreases in lung function, increases in heart attacks, contributes to asthma and increased emergency room visits for asthmatics. Other costs associated with air pollution include loss of visibility associated with haze and particulate matter and reduced recreational values due to impaired ecosystems (i.e., damage to forests or water bodies). All of these costs are included in the damage costs calculated for the GPI using county level damages estimates reported by Muller and Mendelsohn (2007).

TRENDS IN AIR QUALITY IN UTAH

Air quality in Utah is of greatest concern in valley areas that experience temperature inversions associated with topography. During inversions, the Wasatch Front and Cache Valley often record the worst air quality in the country. Despite the challenges associated with topography, Utah has significantly cleaner air today compared to 25 years ago (UDAQ 2010). Reductions in emissions since the 1980s, primarily in motor vehicle and industrial emissions, have resulted in improved air quality and visibility throughout the state. We obtained ground-level and point-source emissions for pollutants in each Utah county for 1996, 1999, 2002, 2005, and 2008 from the Utah Division of Air Quality (UDAQ). Six pollutants were included in the analysis: large particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x), sulfur oxides (SO_x), and volatile organic compounds (VOCs). Statewide emissions of nitrogen oxide (NO_x) and particulate matter (PM_{10} and $PM_{2.5}$) rose from 1996 to 2000 and have since dropped back to pre-1996 levels. Statewide emissions of sulfur oxides (SO_x) in 2008 were the lowest of all the emissions inventories available for review. Statewide emissions of volatile organic compounds (VOCs) such as solvents and formaldehyde also increased since 1996, but were reduced slightly since 2003 and 2000 respectively (Table 35). Emissions of carbon monoxide were not included in the damage assessment because they were not included in the damage cost study used for the analysis (Muller and Mendelsohn 2007).

Despite reduced emissions, counties along the Wasatch Front have not been able to attain National Ambient Air Quality Standards (NAAQS) established by the EPA and regulated by the Utah Department of Environmental Quality for PM_{10} (Salt Lake and Utah counties), $PM_{2.5}$ (Cache, Box Elder, Weber, Davis, Salt Lake, Tooele, and Utah counties), and sulfur dioxide (Salt Lake County). Salt Lake and Davis counties have only recently attained the NAAQS for ozone (ozone forms from in the atmosphere from volatile organic compounds and nitrogen oxides) and are being monitored to ensure that compliance is maintained. Ogden, Salt Lake City, and Provo have recently come into compliance with carbon monoxide standards. These cities are operating under a maintenance plan designed to ensure continued compliance with air quality standards. As a result, they are designated as being in *maintenance status* for carbon monoxide by the Utah Division of Air Quality.

Table 35. Summary of air emissions in Utah (tons per year)

	1996	1999	2002	2005	2008
EMISSIONS OF NITROGEN OXIDE (NO_X)					
Cache County	2,938	3,599	4,072	4,092	3,060
Davis County	10,715	9,884	11,087	10,741	8,929
Salt Lake County	41,833	47,821	46,826	38,106	29,793
Utah County	12,829	13,270	13,378	13,592	11,537
Washington County	3,097	5,066	4,637	6,288	4,180
Weber County	6,976	7,253	6,933	6,880	5,517
State of Utah	188,678	205,772	204,740	186,254	178,057
EMISSIONS OF LARGE PARTICULATE MATTER (PM_{10})					
Cache County	4,435	4,146	2,748	3,223	3,457
Davis County	8,179	3,540	3,379	3,863	5,406
Salt Lake County	34,118	13,682	13,701	15,884	17,804
Utah County	13,653	6,886	5,798	7,535	10,180
Washington County	4,170	2,357	2,569	5,948	3,652
Weber County	6,488	3,223	2,768	3,011	3,906
State of Utah	119,185	81,449	76,656	79,890	98,307
EMISSIONS OF FINE PARTICULATE MATTER ($PM_{2.5}$)[1]					
Cache County	1,186	1,108	735	979	781
Davis County	2,256	977	932	1,224	1,155
Salt Lake County	10,353	4,152	4,158	4,860	3,624
Utah County	3,517	1,774	1,494	2,336	2,025
Washington County	1,238	700	763	3,581	769
Weber County	1,714	851	731	940	871
State of Utah	42,068	28,749	27,057	26,485	22,554
EMISSIONS OF SULFUR OXIDES (SO_X)					
Cache County	147	599	191	207	99
Davis County	2,737	2,424	2,441	3,483	1,633
Salt Lake County	4,922	6,550	5,992	6,082	5,702
Utah County	2,279	1,437	904	721	396
Washington County	18	572	282	273	100
Weber County	161	340	297	240	149
State of Utah	42,862	45,850	49,113	47,910	31,014

	1996	2000	2002	2005	2008
EMISSIONS OF VOLATILE ORGANIC COMPOUNDS (VOCs)					
Cache County	32,542	30,553	18,678	17,728	17,791
Davis County	15,499	16,967	18,879	18,082	17,569
Salt Lake County	56,149	58,222	51,304	48,463	39,270
Utah County	58,340	81,858	36,682	36,856	32,487
Washington County	37,044	30,528	58,743	62,592	57,966
Weber County	24,352	25,115	16,185	15,592	13,709
State of Utah	826,554	958,859	906,189	884,847	865,709

[1]*Note that there are no $PM_{2.5}$ data for 1996 and data for 1999 are incomplete. $PM_{2.5}$ levels for these years were estimated in this study using PM_{10} values adjusted by county specific PM_{10}:$PM_{2.5}$ ratios in 2002.*

Costs of Air Pollution used in GPI

Damages associated with air pollution to human health for the U.S. were at least $70 billion in 2002, which was 94% of the total estimated costs to society associated with air pollution (Muller and Mendelsohn 2007). Ecosystem-related costs of air pollution, , the balance of the damage costs, could be higher than currently estimated because the full impact of poor air quality on ecosystem health is not well understood.

To estimate costs for the years identified in this study, we assumed that the 2008 inventory was representative of 2007, that the 2002 inventory was representative of 2003, that 1999 was representative of 2000, and that 1996 was representative of 1995. Emissions estimates for 1990 are based on 1996 and adjusted for population change. Mueller and Mendelsohn (2009) estimated the total and marginal (additional damage costs per unit ton of pollution produced at current emissions level) damages associated with emissions of six different pollutants (ammonia, nitrogen dioxide, PM_{10}, $PM_{2.5}$, sulfur dioxide, and volatile organic compounds) at the county level for the entire U.S. We used the per-ton cost of emissions for each pollutant from ground and point sources that were reported by this study for each of Utah's 29 counties (Table 36) and then estimated the per capita cost per ton. We multiplied the county level emissions estimates for each of the six pollutants by the per-ton cost for each county reported by Mueller and Mendelsohn (2009) to obtain total damages for each county and for the state (Table 37). Because having more people exposed to poor air quality increases the total cost of air pollution, we also adjusted the calculation proportionally with population change. This is a conservative estimate of the costs of air quality. The model used to estimate damage costs, developed and applied by Mueller and Mendelsohn (Yale University) to the entire United States and captures local emissions, local populations, and local dispersion. However, the dispersion model may underestimate air quality and associated costs in Utah's populous valleys where inversions are difficult to capture with a county-level model. Furthermore, the study only accounts for damage costs (health, visibility, etc.) resulting from poor air quality. It does not account for lost economic development opportunities associated with companies choosing to relocate in other cities due to poor air quality in Utah's metropolitan areas.

Table 36. Damage costs associated with ground level sources (stationary and mobile) of emissions in Utah counties (2000 USD per ton emitted)

	Nitrogen oxides (NOx)	Particulate Matter (<10 microns)	Particulate Matter (<2.5 microns)	Sulfur Dioxide (SO2)	Volatile Organic Compounds (VOC)
Beaver County	$204	$115	$653	$586	$76
Box Elder County	$309	$155	$953	$707	$109
Cache County	$434	$262	$1,575	$774	$179
Carbon County	$246	$147	$726	$609	$86
Daggett County	$227	$95	$500	$582	$60
Davis County	$646	$556	$3,646	$842	$407
Duchesne County	$231	$130	$641	$596	$77
Emery County	$311	$147	$834	$811	$98
Garfield County	$277	$120	$726	$781	$84
Grand County	$321	$126	$769	$803	$90
Iron County	$211	$121	$757	$610	$86
Juab County	$203	$103	$577	$575	$67
Kane County	$311	$112	$786	$854	$91
Millard County	$209	$110	$651	$594	$75
Morgan County	$384	$310	$1,888	$751	$213
Piute County	$216	$106	$573	$563	$68
Rich County	$274	$159	$859	$641	$100
Salt Lake County	$571	$2,650	$13,220	$1,883	$1,494
San Juan County	$293	$112	$732	$791	$84
Sanpete County	$238	$151	$920	$618	$104
Sevier County	$201	$101	$536	$547	$63
Summit County	$240	$128	$657	$593	$78
Tooele County	$270	$193	$1,113	$744	$126
Uintah County	$345	$139	$805	$819	$96
Utah County	$469	$434	$2,459	$888	$276
Wasatch County	$453	$346	$2,215	$849	$246
Washington County	$198	$112	$721	$535	$81
Wayne County	$298	$131	$758	$793	$89
Weber County	$684	$469	$3,221	$915	$358

Source: Mueller and Mendelsohn (2009).

Table 37. Damage costs from point source emissions in Utah (2000 USD per ton emitted)

County	Nitrogen Oxides (NOx)	Particulate Matter (<10 µM)	Particulate Matter (<2.5 µM)	Sulfur Dioxide (SO^2)	Volatile Organic Compounds (VOC)
Beaver County	$199	$91	$574	$559	$66
Box Elder County	$251	$111	$703	$618	$80
Cache County	$320	$165	$1,015	$650	$116
Carbon County	$225	$107	$591	$572	$69
Daggett County	$225	$80	$477	$573	$56
Davis County	$436	$309	$2,036	$675	$228
Duchesne County	$222	$98	$545	$568	$64
Emery County	$304	$122	$762	$790	$89
Garfield County	$273	$106	$697	$767	$80
Grand County	$319	$111	$734	$794	$85
Iron County	$205	$93	$622	$572	$71
Juab County	$192	$82	$499	$543	$57
Kane County	$308	$103	$762	$841	$88
Millard County	$202	$90	$581	$570	$67
Morgan County	$288	$189	$1,172	$636	$133
Piute County	$209	$86	$530	$548	$62
Rich County	$235	$111	$642	$588	$75
Salt Lake County	$411	$1,371	$6,895	$1,182	$780
San Juan County	$291	$103	$710	$782	$81
Sanpete County	$211	$106	$671	$563	$76
Sevier County	$192	$80	$475	$522	$55
Summit County	$226	$96	$548	$563	$64
Tooele County	$226	$129	$777	$634	$88
Uintah County	$341	$119	$756	$804	$89
Utah County	$354	$244	$1,427	$697	$161
Wasatch County	$326	$209	$1,353	$686	$151
Washington County	$188	$87	$579	$501	$65
Wayne County	$293	$113	$720	$779	$83
Weber County	$455	$269	$1,846	$715	$206

Total costs of damages associated with air quality continue to rise, especially as population increases lead to more people and property being exposed to poor air quality. Salt Lake County accounts for nearly half of the emissions costs statewide, in large part due to the topography and population in the area (Table 38). In 1995, the cost of air emissions associated with mobile emissions (e.g., cars, trucks) was $136 million and represented 36% of the total damages associated with air emissions in Utah. By 2007, the cost of air emissions associated with mobile emissions had dropped to $66 million and represented 16% of the total cost of air pollution in Utah.

Table 38. Total air pollution cost in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$6.0	$8.1	$8.9	$6.7	$7.5	$7.0
Davis County	$16.4	$21.6	$16.8	$19.5	$22.1	$21.4
Salt Lake County	$218.6	$282.1	$183.9	$180.7	$192.4	$171.0
Utah County	$19.7	$26.8	$29.9	$21.4	$25.8	$26.1
Washington County	$1.3	$2.9	$3.3	$5.8	$9.7	$7.3
Weber County	$14.9	$18.7	$16.7	$13.6	$14.6	$13.5
State of Utah	$282.5	$376.0	$381.3	$396.1	$406.5	$409.0

NOISE POLLUTION

Noise pollution disrupts sleep, recreation, and general well-being. Loud and repeated noises often are the most disturbing. Not only does noise impact the enjoyment associated with our home and work environments but it also can have adverse effects on human health. As such, noise pollution affects our quality of life. Therefore, GPI includes noise pollution as a cost.

TRENDS IN URBANIZATION IN UTAH AND THE U.S.

GPI estimates noise pollution as a function of urbanization. Noise associated with urbanization, such as traffic and construction, is generally viewed to be the primary source of noise pollution. Each U.S. Census reports urban population in addition to total population by county. The 1990 and 2000 Population Census data for urban and total populations in Utah are presented in Table 39. To estimate urban populations in 1995, we averaged the percent of the population that lives in urban areas based on 1990 and 2000 data. Extrapolation since 2000 is based on the percent of urban populations in 2000 and population growth in each county in each year since 2000. Utah is a highly urbanized state, owing to the concentration of population in the Wasatch Front. The percent of the population that lives in urban areas throughout Utah increased only slightly between 1990 and 2000 from 87% to 88%. Most of the urban centers in Utah are situated in the counties selected for the GPI study. The proportion of the state's population that lives in these urban centers has been relatively stable since 1990 (Table 39). By way of comparison, in the U.S. as a whole, the population that lives in urban areas increased from 75.2% in 1990 to 79% in 2000 to 80.8% in 2005 (USCB 1990; USCB 2000).

Table 39. Trends in urbanization in Utah

	1990		2000	
	Urban Population	Percent Urban	Urban Population	Percent Urban
Cache County	70,183	79%	76,187	83%
Davis County	187,941	99%	234,490	98%
Salt Lake County	725,956	99%	887,650	99%
Utah County	263,590	92%	346,214	94%
Washington County	48,560	75%	72,381	80%
Weber County	158,330	93%	183,322	93%
State of Utah	1,722,850	87%	1,970,344	88%

Costs of Noise Pollution Used in Utah GPI

Few studies have evaluated the cost of noise pollution on human health. In 1972, the World Health Organization estimated the damage caused in the U.S. by noise pollution as $4 billion (Congressional Quarterly, Inc. 1972 cited in Talberth et al. 2007), which amounted to $14.62 billion in 2000 USD. In the Utah study, we assumed that the national cost of noise pollution increased by 1% per year from 1973 onward. This assumption was drawn from other GPI studies (Anielski and Rowe 1999; Bagstad and Ceroni 2007; Costanza et al. 2004; Bagstad and Shammin 2009). Assuming that the cost of noise pollution is proportional to the level of urbanization in an area, we scaled the national level damage estimates for the U.S. as a whole to individual counties in Utah by calculating the proportion of the total urban population in the U.S. that lives in each Utah county. This method was also used by other local GPI studies (Bagstad and Ceroni 2007; Costanza et al. 2004; Bagstad and Shammin 2009). In 2000, this equates to an average cost per person of noise pollution in an urban area in the United States of $69.34. Bagstad and Ceroni (2007) note the desire to better measure and characterize the costs of noise pollution among urban, suburban, and rural areas. The calculation would be improved by including other sources of noise, such as aircraft, snowmobiles, and differentiating among urban noise sources by emergency vehicles, construction, and traffic. Ideally, the calculation would be based on real noise data collected throughout the state as recommended by Costanza et al. (2004).

The total cost of noise pollution in Utah has increased steadily since 1990 as a result of the urbanization experienced in the state (Table 40). The largest costs of noise pollution are found in Salt Lake County, the most urbanized county in the state. The per-capita costs do not show as much change in large part because as an area becomes more urbanized there also are more people among whom the total cost is divided.

Table 40. Total cost of noise pollution in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$6.6	$6.4	$6.7	$7.2	$7.6	$8.0
Davis County	$17.7	$18.5	$20.6	$22.6	$24.0	$25.5
Salt Lake County	$68.6	$70.8	$77.9	$81.5	$84.8	$88.3
Utah County	$24.9	$26.8	$30.4	$34.9	$37.6	$41.3
Washington County	$4.6	$5.3	$6.4	$7.7	$8.9	$9.9
Weber County	$15.0	$15.0	$16.1	$16.9	$17.5	$18.1
State of Utah	$162.7	$162.0	$172.9	$186.8	$197.2	$208.9

HOUSEHOLD POLLUTION ABATEMENT

GPI includes household spending to lessen our contribution to pollution. This spending is deducted from personal consumption since pollution is an undesirable side effect of economic activity that reduces psychic income. Currently, households pay to dispose of or to reduce their pollution in three ways: automobile emissions abatement, wastewater treatment (municipal sewage and septic), and solid waste disposal (Anielski and Rowe 1999). Wastewater treatment and solid waste disposal are paid through municipal public utilities in most communities in Utah, though septic system costs in rural Utah are paid to private companies that service septic systems. Catalytic converters and air filters for vehicles are paid for as part of new vehicle purchases and regular vehicle maintenance. These costs are paid to automobile parts and repair shops. The first attempt to quantify the costs of these pollution abatement efforts was published by Vogan (1996). The national GPI focused on personal expenditures on home water and air filters as the cost (Talberth et al. 2007), whereas other local GPI studies included the categories described above (Costanza et al. 2004; Bagstad and Ceroni 2007). We believe that the costs of solid waste disposal and wastewater treatment represent defensive expenditures precipitated by negative consequences associated with consumption and economic activity. For this reason, they are included as costs in the Utah GPI to be deducted from personal consumption expenditures. The cost of abating pollution created by households mitigates more severe future costs associated with pollution, but it does not directly contribute to improved well-being.

MUNICIPAL GARBAGE DISPOSAL

The data reported for Utah represent waste disposed of, but not necessarily generated, in each county. We obtained municipal solid waste data (for transfer stations, incinerators, and landfills) by county from the Utah Division of Solid and Hazardous Waste (UDSHW) for the 1995–2007 time period. To determine total waste *produced* by each county, we accounted for waste transferred from one county to another for disposal. Transferred waste (measured in transfer station data) was subtracted from the total disposal quantity for the county receiving the waste and included in the total disposal quantity for the transferring county that generated the waste. We estimated the garbage generated for 1990 using the change in population between 1990 and 1995. The state-level totals are more accurate than the estimates calculated on a county level because we obtained state-level totals directly from the UDSHW. County level data are less reliable because there is substantial variability in the extent to which construction and demolition waste (which is typically a commercial rather than personal expenditure) is reported separately from municipal waste, which is the waste stream of interest to GPI.

Since 1990, the amount of municipal garbage Utahns generate has risen steadily with population growth and personal consumption (Table 41). The largest increase has taken place in Washington County, which saw a four-fold increase in municipal garbage production between 1990 and 2007. The amount of garbage generated per person rose in the 1990s but has since gone down in most counties across Utah. Per-capita garbage peaked in 2000 and 2003 in most counties and in the state overall (Table 42). Washington County and Salt Lake County are two notable exceptions to this trend. Per-capita garbage generation in Washington County continued to steadily increase. Conversely, in Salt Lake County, per-capita garbage generation steadily decreased. These differences could represent different levels of recycling and composting. Such practices first took hold in Salt Lake County, and only recently have been introduced in many other parts of the state. Nonetheless, Salt Lake County still has the second highest per-capita garbage production (following Washington County) of the six counties included in this study. Utah County has the lowest per-capita generation of municipal garbage; however, this could be a data

Table 41. Tonnage of municipal garbage (including landfill disposal, transfer, and incineration)

	1990[1]	1995	2000	2003	2005	2007
Cache County	52,241	60,781	82,560	84,194	85,363	89,485
Davis County	185,309	212,429	305,891	248,777	231,515	260,202
Salt Lake County	986,569	1,120,736	1,089,477	1,004,234	1,092,685	1,181,747
Utah County	168,744	197,042	318,235	399,793	329,567	276,349
Washington County	45,689	68,000	90,548	132,462	160,737	200,968
Weber County	158,346	177,727	157,432	181,296	200,761	199,534
State of Utah	1,625,609	1,875,670	1,867,240	2,591,285	2,337,346	2,395,743

[1]*No data were available for 1990. These values are based on per capita garbage rates for 1995 multiplied by the population in 1990*

Table 42. Tonnage of municipal garbage, per capita

	1990	1995	2000	2003	2005	2007
Cache County	–	0.74	0.90	0.86	0.82	0.82
Davis County	–	0.98	1.27	0.95	0.83	0.88
Salt Lake County	–	1.35	1.21	1.07	1.12	1.16
Utah County	–	0.63	0.86	0.94	0.72	0.55
Washington County	–	0.93	0.99	1.21	1.26	1.43
Weber County	–	1.00	0.80	0.88	0.94	0.90
State of Utah	–	0.94	0.83	1.07	0.92	0.89

artifact because Utah County reports municipal waste separately from other waste streams to a greater extent than other counties (UDSHW 2007).

The total cost of solid waste disposal for households is available for 2008 at the county level in the ESRI consumer spending dataset (ESRI 2009). These data were converted to 2000 USD and adjusted based on population change to represent the year 2007. The values were then adjusted based on the tonnage of municipal waste that was disposed of within (landfill or incinerated) or transferred out of a county.

Wastewater Treatment

We estimated the population served by public sewers from the number of homes per county with public sewer connections. These numbers were obtained from the U.S. Environmental Protection Agency (EPA) Clean Watershed Needs Survey (EPA 2010) for 1996, 2000, and 2004 (Table 43). We assumed that the population not serviced by public sewers use septic systems for wastewater disposal. Data for households per county were also obtained from the U.S. Census for 1990, 2000, 2003, 2005, and 2007. Data for 1995 were interpolated based on the change in households between 1990 and 2000. The actual number of households per county serviced by a public sewer was assumed to be the population serviced by public sewer divided by the average people per household obtained from the Utah Governor's Office of Planning and Budget (UGOPB 2009). The 2000 and 2004 Davis County data indicate more population connected to public sewer than the population reported for the county by the Utah Governor's Office of Planning and Budget population data report. Therefore, it was assumed that 100% of the county is serviced by sewer. While the data for Weber County in 1990 look suspiciously low, we used the data that were available at the time the analysis was completed (EPA 2010).

Both the total number of people and the percentage of the population serviced by public sewers in the state increased substantially since 1996 (from 33% of the population in 1996 to 88% in 2004). Connections to the public sewer are more common in dense and urban environments. Therefore, it is not surprising that Salt Lake and Davis counties have the highest reported connection rate and Weber and Washington counties have lower rates.

Table 43. Population with public sewer

	Total population with public sewer			Percentage of total population with public sewer		
	1996	2000	2004	1996	2000	2004
Cache County	43,198	74,981	81,720	52%	82%	82%
Davis County	16,000	283,327	344,193	7%	100%	100%
Salt Lake County	178,130	812,552	881,595	21%	90%	92%
Utah County	197,844	336,349	367,221	62%	90%	84%
Washington County	38,948	79,260	90,122	50%	87%	77%
Weber County	3,974	134,955	151,004	2%	68%	72%
State of Utah	665,408	1,960,186	2,162,340	33%	87%	88%

We calculated the cost of water pollution abatement as the cost of wastewater disposal either through septic systems or municipal wastewater treatment for Utah households. We obtained the total cost of water and sewer service and septic maintenance in 2008 at the county level from the consumer spending dataset (ESRI 2009). We converted the costs to 2000 USD and scaled to the years of interest in this study based on the estimated total number of households serviced by public sewers or septic systems.

Emissions of Pollutants from Vehicles

Air pollution abatement costs for vehicles include air filters and catalytic converters. Catalytic converters and air filters for vehicles are paid for as part of new vehicle purchases (captured as a consumer durable in another GPI component) and regular vehicle maintenance. The latter is included in the cost of a new car and captured as a portion of consumer durables. The cost of air filter replacement is a function of vehicle miles travelled in the existing fleet of vehicles in Utah as well as the cost of catalytic converters in new cars. Whereas the number of new vehicle registrations per year (a proxy for new car purchases) is variable between 1990 and 2007 (Table 44), the total vehicle miles travelled steadily increased between 1990 and 2007 (Table 45).

Table 44. Number of new vehicle registrations

	1990	1995	2000	2003	2005	2007
Cache County	1,336	1,554	1,320	1,243	388	516
Davis County	3,160	3,623	3,172	3,983	1,878	2,718
Salt Lake County	12,163	13,817	10,523	6,422	3,195	7,523
Utah County	4,227	4,936	6,818	6,844	2,347	5,219
Washington County	2,320	3,453	2,626	2,494	2,306	2,753
Weber County	2,439	2,738	2,741	1,925	858	1,282
State of Utah	32,459	37,452	35,386	22,074	13,289	24,859

Table 45. Vehicle Miles Traveled (VMT) per year in millions

	1990	1995	2000	2003	2005	2007
Cache County	541.5	630.1	793.4	830.2	911.4	980.9
Davis County	1,473.9	1,689.6	2,089.4	2,242.3	2,349.1	2,520.9
Salt Lake County	5,815.5	6,606.4	7,319.9	7,989.1	8,140.6	8,795.3
Utah County	1,991.5	2,325.5	3,021.6	3,368.8	3,628.5	3,736.3
Washington County	452.1	672.9	900.4	1,006.3	1,137.9	1,382.1
Weber County	1,127.3	1,265.3	1,510.4	1,493.8	1,542.6	1,634.7
State of Utah	16,292.3	18,798.5	22,517.1	23,963.2	25,129.5	26,824.2

We estimated auto emissions abatement costs as the total number of new cars registered multiplied by the cost of catalytic converters (Costanza et al. 2004). The average cost of a catalytic converter in 2008 ranged from $200 to $1500 (according to local auto parts specialists at Napa Auto Parts and the Toyota Wholesale Parks warehouse in Salt Lake City). The average value of $600 was adjusted for inflation to $480 in 2000 USD. Likewise, the average air filter cost in 2008 was $12.64, which was adjusted for inflation to $10.11 in 2000 USD. We assumed that no other air pollution abatement devices are purchased by households. We obtained the total number of new vehicles registered by county from the Utah State Tax Commission (2010). We extrapolated data for 1990 and 1995 from 2000 data based on population changes. We excluded motorcycles because they do not have emission abatement equipment. We calculated the cost of replacement air filters by dividing the estimated vehicle miles traveled (VMT) obtained from the Utah Department of Transportation (UDOT) by the average replacement mileage for air filters of 20,000 miles (Costanza et al. 2004).

Cost of Household Pollution Abatement in Utah Used in GPI

The total cost of household pollution abatement (wastewater, municipal garbage, and air pollution abatement) has increased from $268 million in 1990 to $411 million in 2007. The majority of the cost is associated with wastewater treatment, followed by solid waste disposal, and vehicle emission controls (Table 46).

Table 46. Total cost of household pollution abatement in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$7.8	$9.9	$11.9	$13.0	$13.1	$13.2
Davis County	$30.4	$37.6	$43.8	$44.7	$50.4	$50.5
Salt Lake County	$127.5	$137.2	$141.7	$148.0	$165.8	$168.2
Utah County	$44.4	$60.4	$77.4	$76.8	$65.0	$66.4
Washington County	$7.7	$10.7	$13.3	$16.0	$19.7	$20.0
Weber County	$28.2	$28.2	$27.6	$31.0	$33.0	$33.2
State of Utah	$267.6	$311.6	$350.7	$392.4	$404.3	$410.9

WETLAND ECOSYSTEM SERVICES

Wetlands provide ecosystem services to Utahns through gas regulation and nutrient cycling (nitrogen processing), disturbance regulation (flood control), water quality (purification of water), habitat for birds, and recreation (birding, canoeing, etc.). For example, wetlands naturally filter bacteria and viruses, nutrients, and other harmful constituents from water through biochemical reactions that take place in wetland systems and through direct uptake of pollutants. Wetlands also act as sponges to absorb flood waters and therefore reduce the impact of flooding on human infrastructure (MEA 2005).

Wetlands are relatively rare in arid Utah, increasing the value of each acre of wetlands even more (Ghermandi et al. 2008). Surprisingly, few studies have examined the effects of wetland scarcity on the unit value of ecosystem services provided. Wetlands around Great Salt Lake make up the majority of wetland acreage in the state and provide critical habitat for migratory bird species. Marshy meadows in the mountainous areas of Utah also perform an important regulatory function for water supply and water quality. Wetlands in arid areas, such as western Utah, provide important dust suppression services. The loss of those wetlands could result in increased quantities of dust blown toward the Wasatch Front from the West Desert.

Wetland Data Sources

To assess wetland change for the Utah GPI, we used the 1992–2001 National Land Cover Database: Land Cover Change Retrofit (NLCD-LLCR) dataset (Fry et al., 2009) because it was the best source of information on wetland change. The NLCD-LLCR product is a geographic information system (GIS) dataset developed by the U.S. Geological Survey; it uses satellite imagery to assess nationwide land-use change between 1992 and 2001. The dataset was developed using a consistent mapping methodology for two time periods. Although more detailed information on wetlands is available through the National Wetlands Inventory (USFWS 2010), these data have scattered availability and in most cases apply to only one time period. Although NLCD-LLCR is the best source available to objectively assess land use for two time periods, its primary limitation is its coarse geographic scale. As a result, the estimates provided are more accurate at the state level than the county level. We used a linear interpolation method based on 1992 and 2001 NLCD-LLCR data to interpolate/extrapolate the number of acres of wetland for the years in the Utah GPI study (1990, 1995, 2000, 2003, and 2007). Once newer data are available, the interpolation will be much improved.

Wetland Trends in Utah

In general, wetland acreage increased by 13% statewide between 1992 and 2001, especially in Salt Lake County and Utah County (Table 47). The reasons for these changes in wetland acreage are not fully understood. There was a significant loss (10%) of wetland acreage in Washington County, which is likely associated with development in the area.

Table 47. Wetland acreage change in Utah

	1992 (acres)	2001 (acres)	Change in Acres	Percent Change
Cache County	13,342	14,014	672	5%
Davis County	12,630	12,409	-221	-2%
Salt Lake County	16,021	19,033	3,012	19%
Utah County	15,343	18,389	3,046	20%
Washington County	7,635	6,885	-750	-10%
Weber County	16,789	18,040	1,251	7%
State of Utah	315,148	356,556	41,408	13%

Value of Wetlands used in GPI

For the Utah GPI, we calculated the value of ecosystem services provided by wetlands in Utah, whereas the national GPI and other state GPI studies estimate the cost of the loss of ecosystem services associated with the loss of wetlands. We chose to avoid the problem of having to select a base year from which to calculate losses and the problem of identifying the total wetland acreage associated with the ideal base year. In our approach, changes in wetland coverage will appear over time as either reductions or additions in values associated with wetland ecosystem services. We believe that this is more consistent with the goals of GPI to value those services that are not traditionally accounted for in economic metrics and to deduct the negative externalities. We prefer to show ecosystem services as direct values rather than to deduct the cost of their loss. In essence, we treat ecosystem services much like the services provided by volunteer and household labor (other components of GPI).

To determine appropriate wetland values per acre, we evaluated several studies (Costanza et al. 1997a; Moeltner and Woodward 2009; Dodds et al. 2008; other GPI studies). We selected the Dodds et al. (2008) estimate of $22,453 per acre (in 2000 USD) because it is the most recent, is applicable to the western U.S., represents a range of wetland types and functions, and provides values for the other land-cover types included in the GPI study. The total value of wetlands calculated for use in the GPI is obtained by multiplying the acreage of wetlands by the value per acre. The total wetland value in the state increased from $6.9 billion in 1990 to $8.6 billion in 2007 (Table 48).

Table 48. Total value of wetlands in Utah in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$296.2	$304.6	$313.0	$318.0	$321.4	$324.7
Davis County	$284.7	$281.9	$279.2	$277.5	$276.4	$275.3
Salt Lake County	$344.7	$382.3	$419.8	$442.4	$457.4	$472.4
Utah County	$329.3	$367.3	$405.3	$428.1	$443.3	$458.5
Washington County	$175.2	$165.8	$156.5	$150.8	$147.1	$143.4
Weber County	$370.7	$386.3	$401.9	$411.3	$417.5	$423.8
State of Utah	$6,869.4	$7,385.9	$7,902.5	$8,212.4	$8,419.0	$8,625.6

CROPLAND

Agriculture has been an integral component of the Utah landscape at least since the land was settled in the 1840s by Mormon pioneers. Prime farmland is relatively scarce in the state. The majority of cultivated crops are grown in valleys fed by mountain runoff. In 2007, Utah had 1.8 million acres of cropped farmland with the majority of farms cultivating less than 100 acres. Today, the most common agricultural commodities grown in Utah are dairy, cattle, hay, hogs, and greenhouse products. The counties with the most farmland in the state are Beaver, Utah, Box Elder, Millard and Cache (Economic Research Service, USDA 2010). In this component of GPI, we aim to capture the value of croplands in terms of the option value[12] associated with preservation of cropland for future production of food. We do not aim to capture the value of the commodities produced on farmland because these already are accounted for in GPI through the personal consumption expenditure by farm households and others in the agricultural sector.

TRENDS IN CROPLAND ACREAGE ACROSS UTAH

We determined the USDA Census of Agriculture for 1987, 1992, 1997, 2002, and 2007 was the best source of information for change in farmland acreage (USDA 2010). These data are available online at the USDA's Census of Agriculture website (USDA 2010). The publications provide the number of acres in farmland production, by year, for each county in the state. We used the total number of acres in cropland (for each year a USDA census was

[12] Option value is the value of preserving the option to use an ecosystem in the future, in this case the option to use lands to produce food.

available) to assess the value of ecosystem services provided by farmland. To interpolate the number of acres of cropland for the years in the Utah GPI study (1990, 1995, 2000, 2003, and 2007), we used a linear interpolation based on the data available in the 1987, 1992, 1997, 2002, and 2007 censuses. Prime farmland is land that has the best soil conditions, growing season, and moisture supply to produce economically sustained high yields of crops. We considered the cropland statistics reported by the USDA (2010) to be the best proxy for prime farmland in the state. We chose not to calculate all types of farmland acreage because some of these are also captured in the grassland and forest land-cover acreages, especially in the case of farmlands used for grazing livestock. Between 1987 and 2007, total cropland in Utah was reduced from just over 2 million acres to 1.8 million acres. These trends are relatively consistent across the state with the sharpest recent decline in Davis County and an increase in Washington County (Table 49).

Table 49. Cropland change in Utah

	1987	1992	1997	2002	2007
Cache County	171,545	175,063	177,117	145,751	143,716
Davis County	30,376	27,242	27,034	26,632	12,383
Salt Lake County	39,582	39,582	40,035	29,303	29,127
Utah County	135,352	151,347	149,920	142,808	117,766
Washington County	28,188	32,612	34,916	41,427	42,847
Weber County	46,343	50,283	39,661	39,336	31,251
State of Utah	2,028,537	2,093,779	2,069,751	2,067,437	1,837,904

Value of cropland used in GPI

We estimated the option value of Utah cropland based on the market value of preserving agricultural lands through conservation easements. We obtained conservation easement purchase prices for twelve agricultural properties purchased with support from the LeRay McAllister Critical Land Conservation Fund (UGOPB 2010b). Purchase prices were converted to 2000 USD. Values ranged from $578.79 per acre for Wilcox Ranch in Emery County to $66,935 per acre for Wheadon Farm in Salt Lake County. Purchase prices were discounted for 25 years at a 5% discount rate to calculate the annual value of preservation of farmland. A value of $436 per acre was used for croplands in Cache County, $430 per acre was used for croplands in Washington County, and $1,910.30 per acre was used for croplands in counties along the Wasatch Front (Davis, Weber, Salt Lake, and Utah counties). The difference in values around the state reflects scarcity of remaining farmland more than the productive value of lands. These values could be greatly refined with more conservation easement data in the future. The total value of cropland in Utah, calculated as the product of cropland value per acre and cropland acreage, was $1.6 billion in 2007 compared to $1.7 billion in 1990 (Table 50).

Table 50. Total value of cropland in Utah in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$76.1	$72.4	$68.7	$66.5	$65.0	$63.5
Davis County	$57.0	$50.0	$43.1	$38.9	$36.1	$33.3
Salt Lake County	$76.2	$70.2	$64.3	$60.7	$58.3	$55.9
Utah County	$278.1	$269.7	$261.4	$256.3	$253.0	$249.7
Washington County	$13.2	$14.8	$16.5	$17.4	$18.1	$18.7
Weber County	$90.0	$82.2	$74.3	$69.6	$66.5	$63.3
State of Utah	$1,722.5	$1,688.7	$1,654.9	$1,634.6	$1,621.1	$1,607.5

FOREST ECOSYSTEM SERVICES

Forests provide ecosystem goods and services to Utahns primarily through gas regulation (carbon sequestration), nutrient cycling (nitrogen processing), water quality (soil erosion control and water filtration), commodities (timber), habitat for wildlife, and recreation (hiking, camping, etc.). For example, through photosynthesis, forests remove carbon dioxide from the atmosphere and capture it in plant tissue. This process also results in the release of oxygen to the atmosphere. Forests play a role in the maintenance and improvement of water quality by acting as soil anchors through tree roots and by the uptake of some pollutants. This function was recognized relatively early on in the Salt Lake Valley, resulting in restricted uses of forested canyons along the Wasatch Front in order to project water supply for residents in Salt Lake County. In order to protect the watersheds around Salt Lake, timber harvest, livestock grazing, and domestic animals have not been allowed in the canyons since 1914 (personal communication with Florence Reynolds, Salt Lake City on June 14, 2010). Prior to this protection, the Wasatch Front was subject to catastrophic flooding and debris flows until the late 1930s, due to years of overgrazing. Effective watershed rehabilitation was implemented in the 1930s and 1940s.

Northern Utah forests are primarily mixed coniferous-aspen forests typical of high-elevation Rocky Mountain forests and mid-elevation scrub oak-mountain mahogany forests that are unique to the Great Basin. Lodgepole pine is an important component of high-elevation forests and is highly desired by the timber industry. Also, pinyon-juniper forests are found in mid-elevation, high desert ecosystems throughout Utah. Utah forests provide the structure for diverse ecological communities and serve as important habitat for migratory songbirds as well as raptors, bats, and other wildlife throughout Utah.

FOREST TRENDS IN UTAH

As in the case of wetlands (and grasslands and scrublands), we used the 1992–2001 NLCD-LLCR (Fry et al., 2009) dataset because it is the best source of information on forest change. Other sources were investigated (e.g., Comprehensive Inventory or Utah's Forest Resources, O'Brien 1999) but they either did not provide multiyear assessments or were not as comprehensive as the NLCD-LLCR. The NLCD-LLCR is a GIS dataset developed by the USGS using satellite imagery to assess nationwide land-use change between 1992 and 2001. The dataset was developed using a consistent mapping methodology for two time periods. Although it is the best source available to objectively assess land use for two time periods, its primary limitation is its coarse geographic scale. Therefore, the estimates of land-use change are more accurate at the state level than the county level. Based on the 1992 and

2001 NLCD-LLCR data, we used a linear interpolation method to interpolate/extrapolate the number of acres of forest for the five years of the Utah GPI study (1990, 1995, 2000, 2003, and 2007). Additional data for 2007 would help to improve this interpolation. In general, forest acreage decreased by 2% statewide between 1992 and 2001 (Table 51). However, at the county level the amount of loss is within the level of uncertainty associated with the data and thus may not accurately represent a true loss in each county. The largest losses of forest were in Salt Lake and Utah counties.

Table 51. Forest acreage change in Utah

	1992 (acres)	2001 (acres)	Change in Acres	Percent Change
Cache County	330,026	329,453	-573	0%
Davis County	43,862	43,259	-603	-1%
Salt Lake County	139,185	132,005	-7,180	-5%
Utah County	614,022	596,950	-17,072	-3%
Washington County	619,925	615,546	-4,379	-1%
Weber County	147,231	147,047	-184	0%
State of Utah	13,829,272	13,565,693	-263,579	-2%

Value of Forest ecosystem Services used in GPI

We calculated the value of ecosystem services provided by forests in Utah, rather than as the loss of their value as used in other GPI studies (see Value of Wetland Ecosystem Services section above). To identify an appropriate forest value per acre, we evaluated several studies related to forest values (Costanza et al. 1997a; Dodds et al. 2008; other GPI studies). As in the case of wetlands, we relied on the per-acre estimate provided by Dodds et al. (2008), because it is the most recent, it differentiates Western forested mountains (from Eastern temperate and West Coast marine forests), and provides values for the other land-cover types included in the GPI study. This study also takes into account ecosystem condition, valuing native habitat explicitly. The forest value per acre ($875 per acre in 2000 USD) multiplied by the acreage of forests in Utah yields the total value of forest ecosystem services calculated for use in the GPI. The total value of forests decreased from $12.2 billion in 1990 to $11.7 billion in 2007 (Table 52).

Table 52. Total value of forest in Utah in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$289.0	$288.7	$288.4	$288.3	$288.2	$288.1
Davis County	$38.5	$38.2	$37.9	$37.8	$37.6	$37.5
Salt Lake County	$123.2	$119.7	$116.3	$114.2	$112.8	$111.4
Utah County	$540.8	$532.5	$524.2	$519.2	$515.9	$512.6
Washington County	$543.5	$541.4	$539.3	$538.0	$537.1	$536.3
Weber County	$128.9	$128.8	$128.7	$128.7	$128.6	$128.6
State of Utah	$12,156.9	$12,028.7	$11,900.5	$11,823.6	$11,772.4	$11,721.1

DESERT GRASSLAND AND SCRUBLAND ECOSYSTEM SERVICES

Utah's desert areas are primarily scrublands dominated by sagebrush and other shrubs (e.g., shadscale) mixed with grasses and other flowering plants. Desert grasslands and scrublands provide ecosystem goods and services to Utahns primarily through soil erosion control (dust regulation), nutrient cycling, recreation (hiking, camping, off-road vehicles, etc.), commodities (range for cattle), and habitat for wildlife (Richardson 2008). Near urban areas, on public lands, and on sites culturally valued by Native Americans, the aesthetic, recreational, and cultural values of deserts are likely to be large (Richardson 2008). Although carbon sequestration and storage is lower in deserts where photosynthesis and dense vegetation growth are limited, Striegl et al. (1992) suggest that deserts play an important role in oxidation of atmospheric methane, an important greenhouse gas. Moreover, providing habitat for pollinators such as desert bats, hummingbirds, and bees may be one of the greatest services that deserts and scrublands provide (Kremen et al. 2007). Many Utah crops rely on this pollination, including orchards and alfalfa. Dust suppression is another important function of deserts. For example, there is some concern that decisions in Nevada to withdraw groundwater from Snake Valley (a valley that crosses the Utah-Nevada border) could reduce plant coverage and thus increase dust yield from Western Utah and further degrade air quality along the Wasatch Front. This would be an example of a loss of an ecosystem service provided by deserts.

DESERT GRASSLAND AND SCRUBLAND TRENDS IN UTAH

We used the 1992–2001 NLCD-LLCR dataset (Fry et al. 2009) because it is the best source of information on grass/herbaceous change. We investigated the 1992 Utah Gap analysis land-cover dataset (Edwards et al. 1995) and the 2001 Southwest ReGAP land-cover dataset (Lowry et al. 2007) and due to inconsistencies in methodology between these two efforts, the NLCD-LLCR provides the best assessment of land-use change currently available. The NLCD-LLCR dataset is a spatial GIS dataset developed by the USGS; it uses a consistent mapping methodology to assess nationwide land-use change between 1992 and 2001. Although it is the best source available to objectively assess land use for two time periods, its primary limitation is its coarse geographic scale. To assess grass/herbaceous change for the Utah GPI, we used a linear interpolation method based on 1992 and 2001 NLCD-LLCR data to interpolate/extrapolate the number of acres of grass/herbaceous land for the five years of the Utah GPI study (1990, 1995, 2000, 2003, and 2007). Additional data for more recent years would help to improve this interpolation.

In general, acreage of grassland and scrubland in Utah has stayed relatively constant over time (Table 53). This is somewhat surprising because this land cover has the greatest chance of being developed outside of existing urban areas. Development certainly accounts for the majority of the loss of this land-cover type in Salt Lake and Davis counties. Changes in other counties and at the state level, however, are within the uncertainty range associated with the data and methods used in the study, and may not represent true change.

Table 53. Desert grassland and scrubland change in Utah

	1992	2001	Change in Acres	Percent Change
Cache County	199,302	196,924	-2,378	-1.2%
Davis County	39,322	36,592	-2,730	-7.5%
Salt Lake County	134,550	118,111	-16,439	-13.9%
Utah County	451,163	441,220	-9,943	-2.3%
Washington County	849,752	848,044	-1,708	-0.2%
Weber County	82,041	80,548	-1,493	-1.9%
State of Utah	30,221,966	30,223,772	1,806	0.0%

VALUE OF DESERT GRASSLANDS AND SCRUBLANDS USED IN GPI

We calculated the value of ecosystem services associated with grasslands and scrublands in Utah, rather than as the loss of the value of these services as presented in other GPI studies (see Value of Wetland Ecosystem Services section above). Deserts are arguably one of the most poorly studied ecosystems in the world in terms of the ecosystem services they provide. Costanza et al.'s (1997) well-known work on the global value of ecosystem services did not place a value on deserts. Although more studies concerning the economic value of desert ecosystem services have been completed in the last decade, such studies are still much scarcer than those on forests, wetlands, and aquatic systems. We reviewed several studies related to open space, range value, and grassland and scrubland values (Dodds et al. 2008; Richardson 2008; Pope and Jones 1990; Richer 1995; Rosenberger and Walsh 1997; Nahuelhaul et al. 2004; Keith et al. 1996). We selected the Dodds et al. (2008) estimate of $147 per acre (in 2000 USD) for North American deserts because it is the most recent, and because it provides values for the other land-cover types included in the GPI study, such as wetlands and forests. Valuing the estimated acreage of grasslands and scrublands at $147 per acre indicates that between 1990 and 2007, the total value of grass and scrublands stayed relatively constant in the state at $4.4 billion (Table 54).

Table 54. Total value of grasslands and scrublands in Utah in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$29.4	$29.2	$29.0	$28.9	$28.9	$28.8
Davis County	$5.9	$5.7	$5.4	$5.3	$5.2	$5.1
Salt Lake County	$20.4	$19.0	$17.7	$16.9	$16.3	$15.8
Utah County	$66.8	$66.0	$65.2	$64.7	$64.3	$64.0
Washington County	$125.2	$125.1	$124.9	$124.9	$124.8	$124.8
Weber County	$12.1	$12.0	$11.9	$11.8	$11.8	$11.7
State of Utah	$4,451.8	$4,452.0	$4,452.1	$4,452.2	$4,452.2	$4,452.3

NONRENEWABLE RESOURCE DEPLETION

GPI includes an estimate for the depletion of natural capital in order to assess the sustainability of income and consumption levels in the future. The depletion of nonrenewable resources results in a net loss of wealth to Utah and is a source of income that cannot be sustained into the future.

TRENDS IN ENERGY PRODUCTION AND CONSUMPTION IN UTAH

We obtained energy production data at the state level for coal, natural gas, total petroleum, and electricity for residential energy uses for all of the years included in this study from the U.S. Department of Energy, Energy Information Administration (USDOE 2010; Table 55). In addition, we obtained residential energy consumed at the state level by source (Table 56) and transportation energy consumption (Table 57).

Table 55. UT energy production (trillion BTU)

	1990	1995	2000	2003	2005	2006
Coal	511.4	586.4	631.3	536.2	554.2	593.3
Natural gas	189.3	279.4	302.2	289.1	322	372.4
Crude oil	160.1	115.9	90.7	76	96.6	103.9

Table 56. UT residential energy consumption (trillion BTU)

	1990	1995	2000	2003	2005	2007
Coal	1.2	0.2	0.1	0.2	0.1	0
Natural gas	47.3	52.1	58.5	58.1	61.2	64.4
Total Petroleum	2.4	1.2	2.6	2.4	3.6	3.1
Electricity	14.5	17.2	22.2	24.5	25.8	29.9

Table 57. Utah transportation energy consumption (trillion BTU)

	1990	1995	2000	2003	2005	2007
Natural gas	1	3.3	3.7	8.4	9.5	12.9
Crude oil	147.7	178.2	217.2	213.9	227.6	249.1

COST OF NONRENEWABLE RESOURCE DEPLETION FOR USE IN GPI

GPI studies employ either production values or consumption values to estimate the cost of nonrenewable resource depletion at the state level. Neumayer (2000) discusses the differences between consumption-driven methods and production-driven methods to estimate the costs of nonrenewable resource depletion:

- Production-driven methods essentially calculate the value of the nonrenewable resources produced in a year that is permanently lost from an area, such as Utah. This method is referred to as a *resource rent approach* in order to capture the loss of the resource and its associated wealth to future generations.

- Consumption-driven methods use a *replacement cost approach* to value the permanent loss of the wealth associated with the resources consumed, regardless of where they are produced.

Most state-level GPI studies focus on the consumption-driven, replacement cost method (Costanza et al 2004; Bagstad and Ceroni 2007; Venetoulis and Cobb 2004) to capture the cost of nonrenewable resources consumed in a state regardless of where they were produced. However, the national GPI study used a production-driven resource rent approach (Anielski and Rowe 1999) to capture the costs of all nonrenewable energy produced in the USA regardless of where it is consumed. As a measure of sustainable income from resource extraction for the nation, production-based approaches are the most relevant. However, this method is less relevant at the state level because production and consumption values are not well-matched at this scale. For example, Utah is a net energy exporter, so much of the energy produced in Utah is actually consumed elsewhere. Because the GPI study begins with personal consumption, we felt that a consumption-based approach was more appropriate for the Utah GPI. Once nonrenewable resources are depleted, consumers will bear the cost of replacement, regardless of where they originated. Moreover, the replacement cost of nonrenewable energy sources is especially relevant for policy makers in today's shifting economy as we begin to replace nonrenewable energy with large-scale renewable energy projects including wind, solar, biomass, and geothermal.

We used the consumption data from the Energy Information Administration in the U.S. Department of Energy to obtain total expenditures on residential energy consumption for coal, natural gas, petroleum and electricity at the state level for 2008. To calculate the total replacement cost of these energy sources, we assumed a replacement cost of $109.17 per barrel equivalent (2000 USD) of crude oil used, which Anielski and Rowe (1999) assumed to be the cost of replacing oil with biofuels. This cost includes the externalities associated with scaling up ethanol production in the U.S., such as loss of food production. We used a replacement cost for electricity of 8.75 cents/kWh, which is the estimated cost of replacing all electricity with wind and solar sources (Makhijani 2007), assuming that wind and solar are used equally to replace current electricity generation. We also assumed that all of the energy generated by coal would be replaced by renewable energy, that 30% of natural gas would be replaced with electricity, and that 70% of natural gas would be replaced with biofuels. These assumptions are based on currently available alternative energy sources in Utah**.** Additional renewable sources may replace nonrenewable resource extraction in Utah in the future, such as ground source heat pumps. Furthermore, the replacement costs associated with renewable energy also are likely to change with improvements on renewable technologies and increased demand for renewable energy. Nonetheless, we found these values to be the best estimates available to date.

Total replacement costs for the state of Utah were calculated as the product of total energy consumption use (for each category) and the cost per unit of energy consumed. We apportioned the 2008 costs down to counties using the percentage of total state residential energy use consumed by each county in the form of natural gas, electricity, and fuel oil as reported in the consumer spending dataset (ESRI 2009). We used the electricity purchasing patterns to represent coal-use trends at the county level. Similarly, the transportation costs were apportioned to counties for 2008 of percentage of total state transportation expenditures by county in the form of natural gas, diesel, and gas, as reported in the consumer spending data for transportation energy (ESRI 2009). Finally, we scaled the county level 2008 costs back to other years based on total nonrenewable energy consumption at the state level, assuming that the proportion of the state total that each county represents stays constant over time (Table 58).

Table 58. Total cost of nonrenewable energy consumption in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$128.1	$151.5	$182.8	$183.5	$195.8	$214.2
Davis County	$453.4	$536.2	$646.8	$649.6	$693.0	$758.1
Salt Lake County	$1,538.8	$1,819.0	$2,194.8	$2,204.2	$2,351.8	$2,572.3
Utah County	$598.2	$708.0	$854.0	$857.4	$914.4	$1,000.5
Washington County	$169.6	$200.5	$242.2	$243.1	$259.4	$283.8
Weber County	$310.9	$367.0	$442.7	$444.9	$474.9	$519.2
State of Utah	$3,720.7	$4,398.7	$5,307.8	$5,330.1	$5,687.0	$6,220.3

CLIMATE CHANGE

Climate change has been attributed to changes in concentrations of greenhouse gases, such as carbon dioxide, associated with increased emissions of these gases due to energy use. Impacts and costs of climate change are inherently both regional and local. The primary direct costs of climate change in the Rocky Mountains are associated with losses due to its impacts on tourism and outdoor recreation, especially the ski industry, as well as industries such as forestry. More arid conditions, especially in Southern Utah, but also in the population centers along the Wasatch Front also could result in increased water scarcity, impacts to property values, and impacts to human health (University of Maryland 2008). Impacts to water resources could have repercussions on cultivated agriculture, livestock ranching, outdoor recreation and tourism, and natural ecosystems (Wagner et al. 2003). The cost of climate change to Utahns is calculated for the GPI using global-level cost estimates and Utah-specific carbon emissions.

TRENDS IN CARBON EMISSIONS IN UTAH ASSOCIATED WITH PERSONAL CONSUMPTION

We obtained consumer-spending data for 2008 at the county level from ESRI and assigned a *carbon intensity* (defined as pounds of carbon emitted per dollar spent) for each category as reported in Shammin and Bullard (2009). The carbon intensity measure accounts for emissions outside of Utah that occur as a result of consumption patterns by Utahns. The consumption categories included in the analysis are: food, alcohol, dwellings (owned and rented), lodging, natural gas, electricity, fuel oil, bottled gas, coal, wood, phone, water and sewer, housekeeping, household furnishings, apparel and services, new and used cars/trucks/vans, other vehicles, gasoline, diesel, motor oil, public transportation, air travel, health care, entertainment, personal care, education, tobacco, insurance, and miscellaneous purchases. We expressed the total carbon emissions associated with consumption of these items in metric tons of CO_2 equivalents emitted (Table 59).

Table 59. Carbon dioxide equivalent emissions associated with personal consumption of Utahns (metric tons/year)

	1990	1995	2000	2003	2005	2007
Cache County	1,191,450	1,357,978	1,436,432	1,544,702	1,493,823	1,572,550
Davis County	2,417,692	3,235,537	4,342,267	4,639,255	5,362,204	5,704,252
Salt Lake County	8,628,372	11,516,422	15,058,466	15,618,582	18,216,560	18,972,923
Utah County	3,013,925	4,355,850	5,817,853	6,204,515	7,048,876	7,750,158
Washington County	589,631	1,027,249	1,416,861	1,627,619	2,040,091	2,261,244
Weber County	1,980,569	2,514,892	3,025,173	3,287,908	3,653,921	3,775,277
State of Utah	20,484,542	27,645,691	35,927,219	38,046,435	43,968,747	46,595,163

Cost of Climate Change used in GPI

We obtained the unit cost of CO_2 emissions associated with the impacts of climate change from Tol et al. (2005). This study conducted a meta-analysis of 103 other studies and selected a median value of $89.57 per ton of CO2 (2000 USD) emitted for the year 2004 as an average cost for the impacts of climate change globally. They assumed that costs were $0 in 1963, which is the year that the atmospheric waste absorption capacity begins to be exceeded by human emissions of CO_2, and increases thereafter at a rate of $2.13 per year. Based on this cost per ton of CO_2 emissions, we derived costs for the other years included in the GPI study as follows: $57.58 in 1990, $68.24 in 1995, $78.91 in 2000, $91.70 in 2005, and $95.97 in 2007, all in 2000 USD. These estimates assume a linear increase in the cost of emissions, which is not tied to any actual emissions trajectory but is the most reasonable estimate we could make at this time.

Emissions for years before 2008 were extrapolated using the 2008 population and scaling for changes in personal consumption as calculated at the beginning of the GPI. The estimates were then corrected for changes in carbon intensity associated with consumption using intensities reported by Shammin et al. (2010). Consumption today has less embodied energy (and carbon) per unit than consumption of the same good 15 years ago due to increases in production efficiency.

The total cost of climate change associated with consumption by Utahns was $4.5 billion in 2007 (Table 60). This cost is not evenly distributed around the globe because impacts and costs of climate change in a given region are not directly linked to emissions from that region. For example, projected sea level rise will impact small island developing states (Bahamas, Tahiti, Fiji, etc.) more than other countries because much of their land and infrastructure will be lost. However, these countries are relatively small contributors of greenhouse gases compared to the rest of the world. Nonetheless, we found this estimate to be a good starting place for estimating climate change impacts to Utah. In the future, a Utah-specific study evaluating the cost of the impacts of climate change to Utah's economy would be helpful for decision makers and for inclusion in future GPI studies.

Table 60. Total cost of climate change resulting from emissions associated with consumption by Utahns in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$69	$93	$113	$132	$137	$151
Davis County	$139	$221	$343	$396	$492	$547
Salt Lake County	$497	$786	$1,188	$1,332	$1,670	$1,821
Utah County	$174	$297	$459	$529	$646	$744
Washington County	$34	$70	$112	$139	$187	$217
Weber County	$114	$172	$239	$280	$335	$362
State of Utah	$1,179	$1,887	$2,835	$3,245	$4,032	$4,472

OZONE LOSS

As a result of the Montreal Protocol of 1989, the release of ozone-depleting chemicals such as chlorofluorocarbons (CFCs) declined precipitously to 2% of their 1988 peak by 2003 (AFEAS 2006). Nonetheless, the ozone-depleting chemicals persist in the atmosphere and contribute to environmental and human health costs associated with ultraviolet exposure. Following other GPI studies (Costanza et al. 2004; Bagstad and Ceroni 2007), we estimated the cost of ozone depletion at the national level (which is assumed to be 1/3 of the world production of CFCs) and scaled it down to Utah based on population. This method assumes that the per-capita costs of ozone depletion are the same for all counties and residents. Emissions of ozone-depleting chemicals have gone down globally from a 658,325 metric tons/year in 1990 to 16,653 in 2003. Data for 2005 and 2007 were extrapolated based on the rate of decrease (45%) observed between 2001 and 2003. We used a cost per ton of emissions of $49,669 (at 2000 USD) following Talberth et al. (2007). Thus, the total costs of ozone-depleting chemicals in Utah are expressed as the product of cost per ton, the per-capita emissions of ozone-depleting substances, and the population of Utah.

Table 61. Total cost of ozone depleting chemicals in millions (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$3.09	$0.76	$0.20	$0.09	$0.05	$0.03
Davis County	$8.26	$1.99	$0.51	$0.25	$0.14	$0.08
Salt Lake County	$31.92	$7.62	$1.92	$0.89	$0.50	$0.28
Utah County	$11.65	$2.86	$0.79	$0.40	$0.23	$0.14
Washington County	$2.15	$0.67	$0.19	$0.10	$0.07	$0.04
Weber County	$6.95	$1.64	$0.42	$0.20	$0.11	$0.06
State of Utah	$75.78	$18.38	$4.77	$2.29	$1.31	$0.75
United States	$10,899.45	$2,410.80	$598.08	$275.71	$151.64	$83.40

KEY FINDINGS AND RESULTS

TRENDS IN GPI AND GDP FOR UTAH

Between 1990 and 2007 the aggregate GPI increased, albeit at a slower growth rate than the state GDP. The personal consumption component of GPI is also the largest component of Utah's GDP, which drives the upward trend in both GPI and GDP (Figure 5). The difference in the growth rates between GDP and GPI is accounted for mainly by the increasing costs and decreasing values assigned to social and environmental components of the GPI. Figure 5 also shows that while GPI in the aggregate was driven upward by its economic components, primarily personal consumption, the environmental and social components of GPI trended downward, offsetting some of the economic progress in the state.

The divergence between the GDP and the GPI is even more pronounced in per-person terms (Figure 6). Since 2000, GDP and personal consumption per capita continued to increase while our quality of life, on average, as measured by GPI, increased at a slower rate.

Compared to the U.S. GPI reported in Talberth et al. (2007), Utah's GPI increased at a faster rate in the post-1990 period. This difference is not entirely surprising as it is attributable to the relative magnitude of adjustments in larger components of GPI in the state versus the national GPI. The largest contributors to Utah's GPI are household labor, valued at $12.5 billion in 2007, and services of Utah's forests, wetlands, and deserts, which together contributed $24.8 billion in 2007 (Figure 7). The biggest deductions are the costs of depletion of non-renewable resources, loss of leisure time, and commuting. Each of these additions and deductions is unaccounted for in the national or state income accounts.

Between 1990 and 2007 the total value of household labor in the state increased steadily while the value of ecosystem services held relatively constant. While the total value of wetland ecosystem services increased during this period the loss of total ecosystem service value for Utah—each of the four ecosystem services in Table 62—did not change substantially in the past two decades. On the cost side, the costs of depleting nonrenewable resources, commuting, and lost leisure time all trended upward. Taken together, the social components of GPI amounted to a negative contribution to GPI after 1990 (Figure 5), mainly because the rising cost of lost leisure, commuting, and underemployment more than offset the increase in the value of household labor and volunteer labor.

GPI per capita in Utah also shows an overall upward trend from 1990 to 2007, although at a slower rate than aggregate GPI (Figure 6). The difference in the trends of total GPI and per-capita GPI partly reflects the impacts of population growth on our individual quality of life. The population in Utah grew by 56%, or an average of 3.1% per year, between 1990 and 2007. Population growth contributes positively to GPI (and GDP) through increases in the labor force, which enable higher levels of personal consumption. When expressed in per-person terms, this effect is reduced, which demonstrates that as population increases, our individual quality of life is impacted. On a per capita basis, the economic components of GPI increased while the environmental components indicate an overall decline (Figure 6). On a per-capita basis the social components declined slightly during the same period. In cases where total costs grew by less than the population growth, the per-capita cost will decline because the costs are spread among more members of the community (e.g. costs of crashes). In this case, a higher per-capita GPI is obtained compared to a scenario of lower population growth. Similarly, per-capita values could decline, contributing to a decrease in per-capita GPI, if the population growth rate is greater than the growth rate in total value of a given contributor to our well-being (e.g. the value of household labor). Thus, caution is necessary in interpreting the processes underlying the trend in per-capita GPI and the welfare implications of decline in per-capita costs or per-capita values.

The sharpest increase in per-capita GPI occurred between 1995 and 2000 (Figure 6). The upward trend was very gradual from 2000 to 2007, which appears to be related primarily to a loss in value of environmental components followed by reduced value (and increased costs) associated with social components (e.g., household labor, leisure time, and commuting). Economic components together increased steadily after 1990. From 1990 to 2007, average personal consumption almost doubled. As in the case of aggregate GPI, the largest contributors to per-capita GPI, other than personal consumption, were household labor and ecosystem services (Figure 8). However, both of these components showed overall declines after 1990. The value of ecosystem services provided by wetlands, forests, farmland, and deserts was reduced by 33% due to changes in land use and a larger population among which the services are shared (Table 63). The net value of consumer durables (the value of services provided by household capital minus their purchase cost) went from a net positive ($305 per person) in 1990 to a negative cost of $1,510 per person. The largest per-capita costs captured by the GPI are the loss of nonrenewable resources, lost leisure time, and commuting (Figure 8). During the study period there was a 21% and 30% increase in the cost of leisure time lost and cost of commuting, respectively.

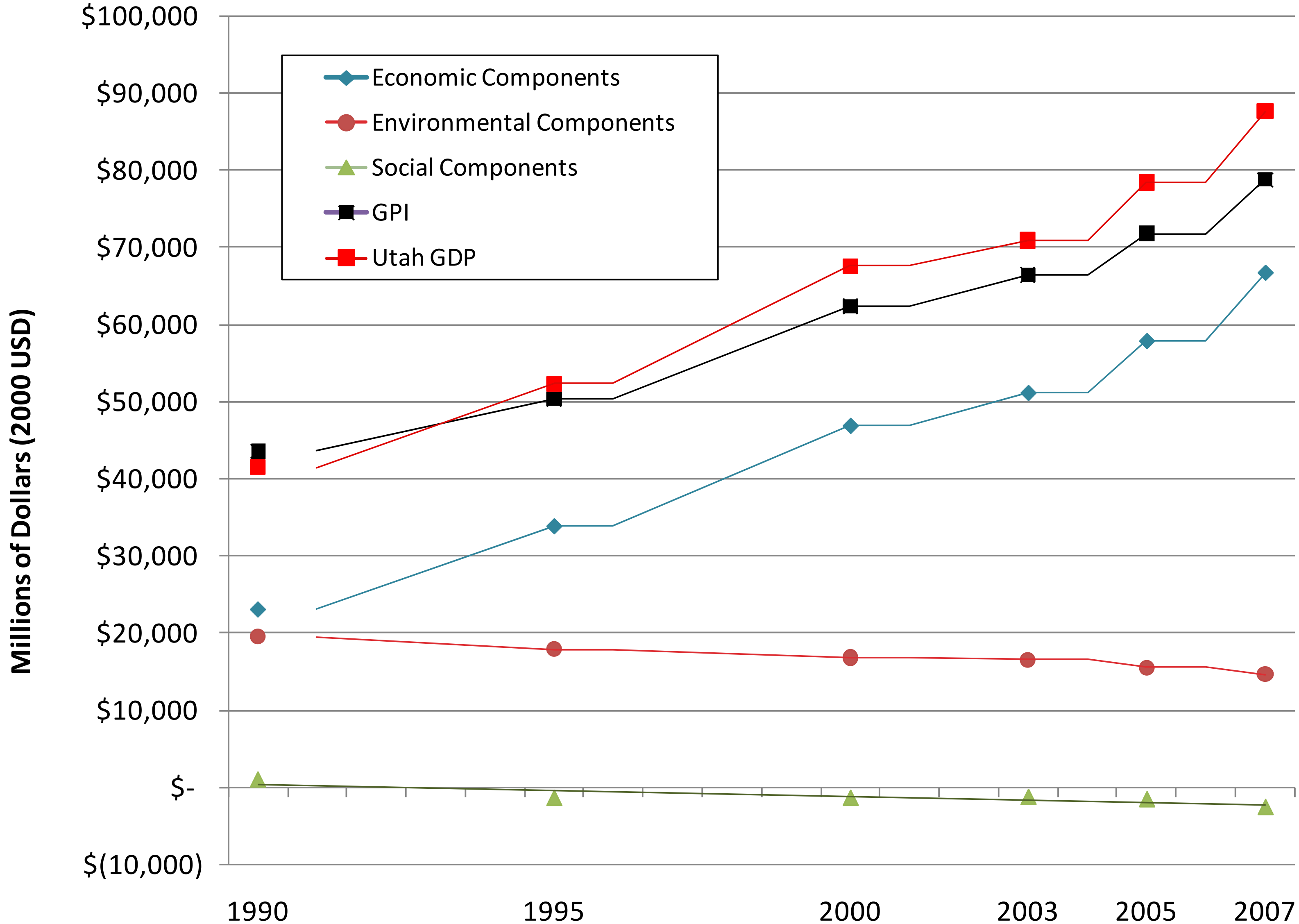


Figure 5. Trends in aggregate Utah GDP, GPI and economic, environmental, and social components of GPI.

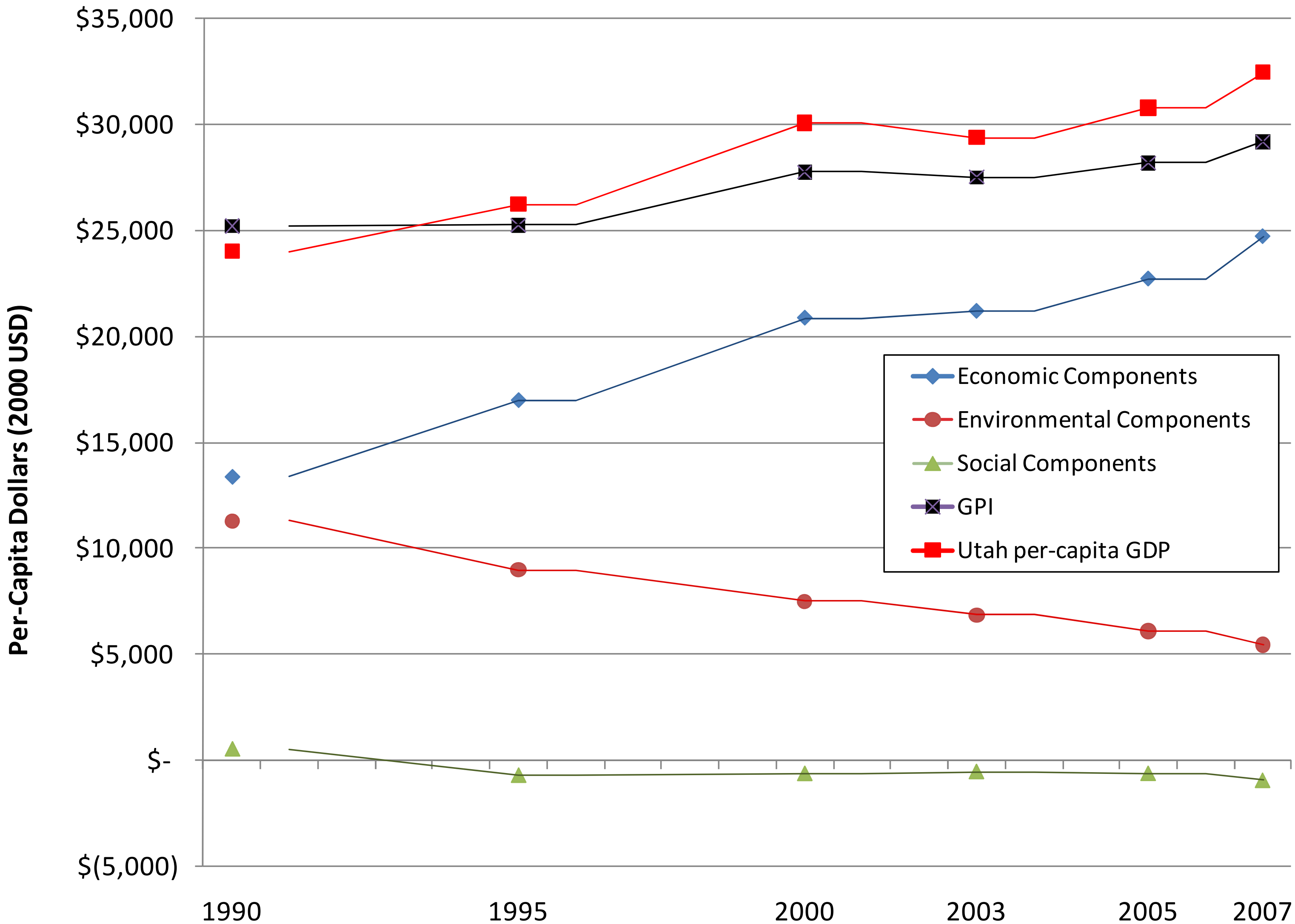


Figure 6. Utah GDP and GPI trends per capita and economic, environmental and social components of GPI.

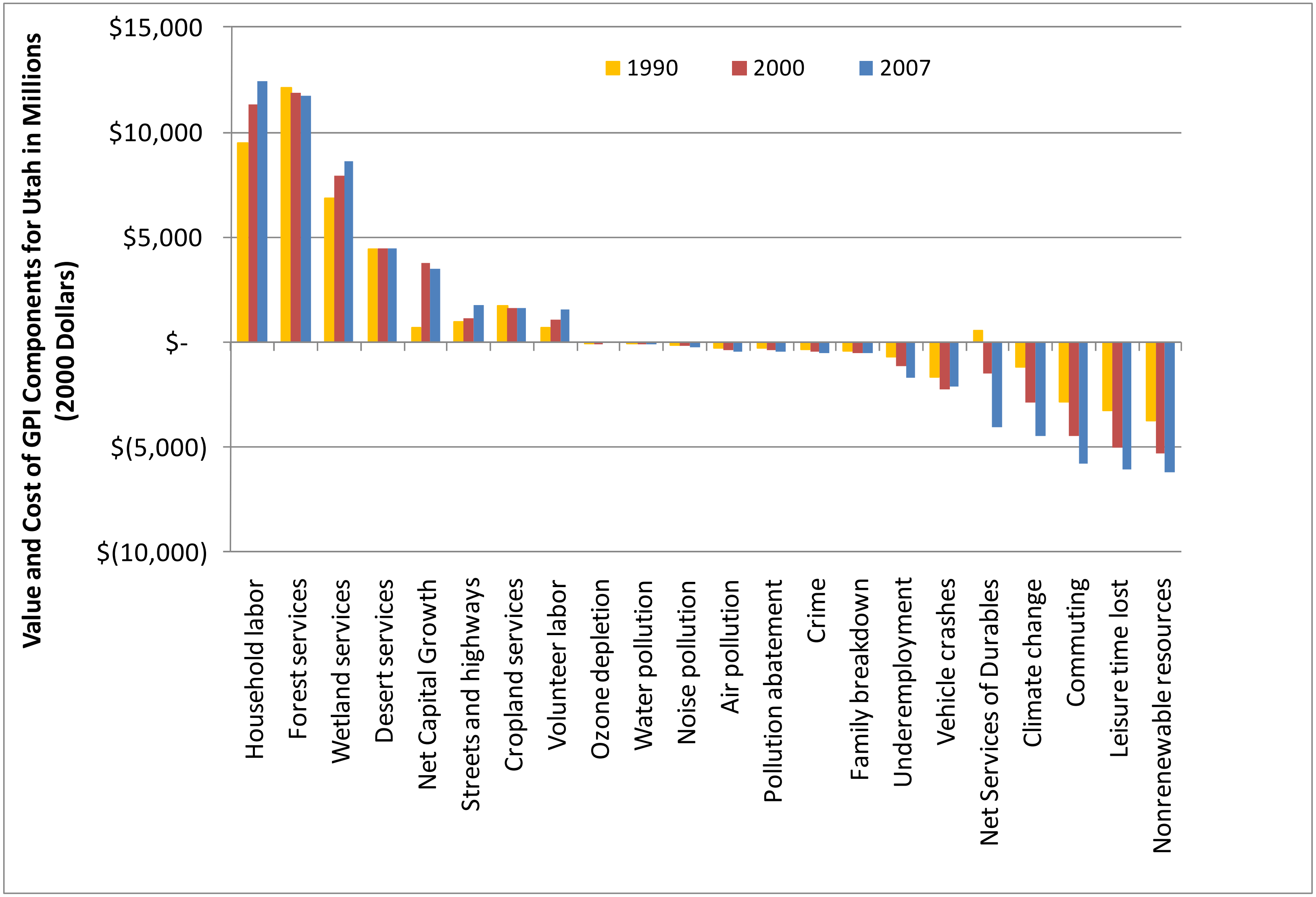


Figure 7. Summary of individual components that contribute to aggregate Utah GPI for 1990, 2000, 2007.
Note: personal consumption, as the starting point, and GPI as the ending point, are not included to provide more detail on the scale of individual components.

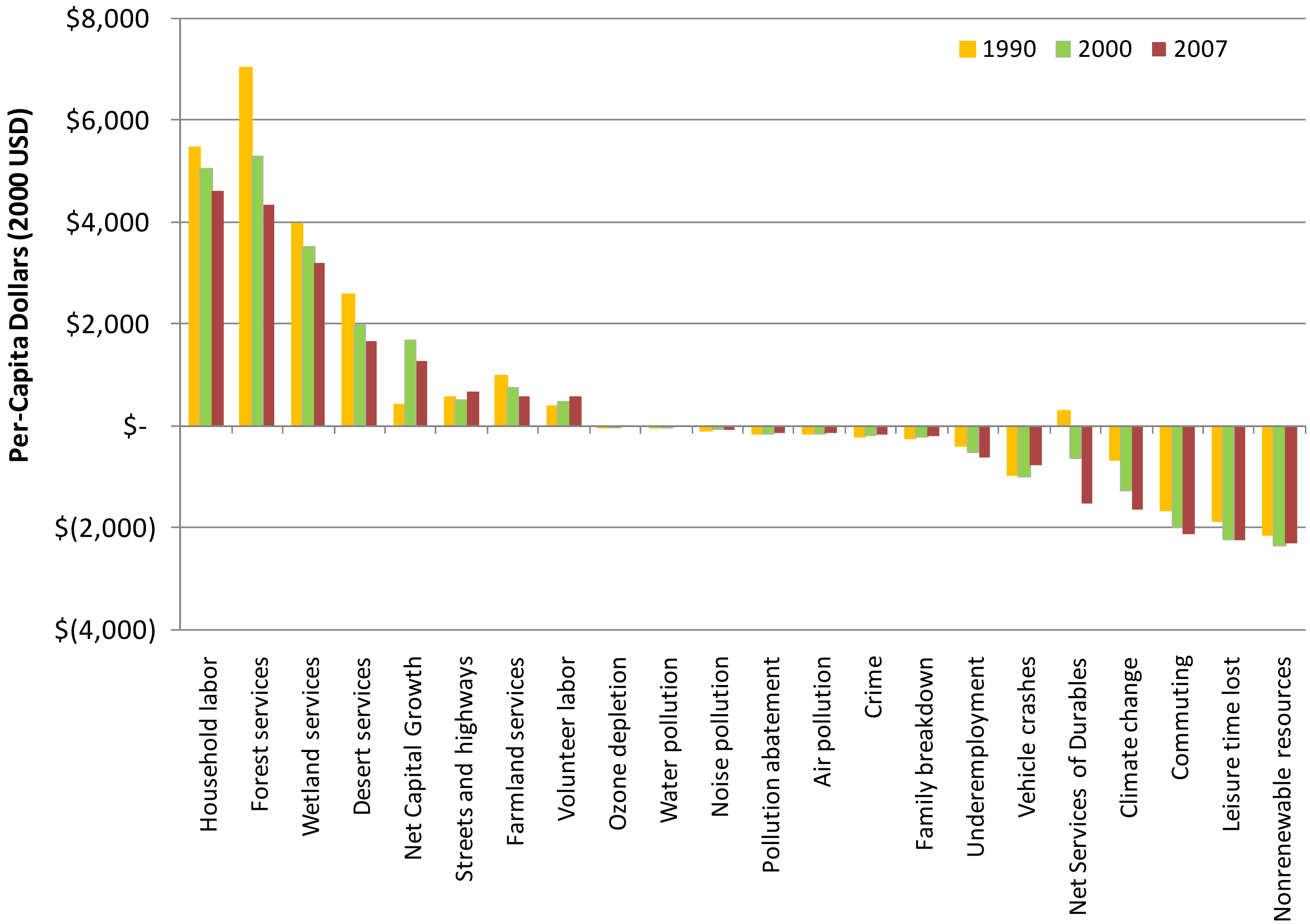


Figure 8. Summary of individual components that contribute to per-capita Utah GPI for 1990, 2000, 2007.
Note: personal consumption, as the starting point, and GPI as the ending point, are not included to provide more detail on the scale of individual components.

Table 62. Summary of aggregate GPI results for Utah (million dollars in 2000 USD)

	1990	1995	2000	2003	2005	2007
Personal consumption	$23,409	$33,852	$48,868	$54,307	$64,175	$72,957
Income inequality	-$2,471	-$2,506	-$5,482	-$4,964	-$7,806	-$7,480
Personal consumption adjusted for income inequality	$20,938	$31,346	$43,386	$49,343	$56,369	$65,477
Household labor	$9,483	$10,420	$11,357	$11,360	$11,568	$12,467
Volunteer labor	$691	$875	$1,059	$1,501	$1,662	$1,596
Services of consumer durables	$3,628	$4,360	$5,325	$5,913	$6,472	$7,048
Streets and Highways	$956	$955	$1,144	$1,208	$1,480	$1,805
Crime	-$371	-$445	-$421	-$446	-$460	-$490
Family breakdown	-$436	-$445	-$497	-$516	-$539	-$538
Leisure time lost	-$3,216	-$4,829	-$5,011	-$4,604	-$4,992	-$6,087
Underemployment	-$687	-$1,012	-$1,160	-$2,062	-$1,791	-$1,657
Cost of consumer durables	-$3,100	-$4,137	-$6,777	-$8,431	-$9,708	-$11,126
Commuting	-$2,846	-$3,818	-$4,462	-$4,429	-$4,890	-$5,756
Pollution abatement	-$268	-$312	-$351	-$392	-$404	-$411
Vehicle crashes	-$1,680	-$2,161	-$2,269	-$2,096	-$2,142	-$2,111
Water pollution	-$3	-$3	-$3	-$5	-$3	-$4
Air pollution	-$282	-$376	-$381	-$396	-$407	-$409
Noise pollution	-$163	-$162	-$173	-$187	-$197	-$209
Wetland services	$6,869	$7,386	$7,902	$8,212	$8,419	$8,626
Farmland services	$1,722	$1,188	$1,655	$1,635	$1,621	$1,608
Nonrenewable resources	-$3,721	-$4,399	-$5,308	-$5,330	-$5,687	-$6,220
Climate change	-$1,179	-$1,887	-$2,835	-$3,245	-$4,032	-$4,472
Ozone depletion	-$76	-$18	-$5	-$2	-$1	$0
Forest services	$12,157	$12,029	$11,901	$11,824	$11,772	$11,721
Desert services	$4,452	$4,452	$4,452	$4,452	$4,452	$4,452
Net capital growth	$693	$1,360	$3,797	$3,095	$3,227	$3,476
GPI	$43,563	$50,367	$62,326	$66,402	$71,788	$78,784

Table 63. Summary of GPI per-capita results for Utah (2000 USD)

	1990	1995	2000	2003	2005	2007
Personal consumption	$13,537	$16,966	$21,752	$22,500	$25,193	$27,026
Income inequality	-$1,429	-$1,256	-$2,440	-$2,057	-$3,064	-$2,771
Personal consumption adjusted for income inequality	$12,108	$15,710	$19,312	$20,444	$22,128	$24,255
Household labor	$5,484	$5,223	$5,055	$4,707	$4,541	$4,618
Volunteer labor	$399	$438	$471	$622	$652	$591
Services of consumer durables	$2,098	$2,185	$2,370	$2,450	$2,541	$2,611
Streets and Highways	$553	$478	$509	$500	$581	$668
Crime	-$215	-$223	-$187	-$185	-$181	-$182
Family breakdown	-$252	-$223	-$221	-$214	-$212	-$199
Leisure time lost	-$1,860	-$2,420	-$2,230	-$1,908	-$1,960	-$2,255
Underemployment	-$397	-$507	-$516	-$854	-$703	-$614
Cost of consumer durables	-$1,793	-$2,073	-$3,016	-$3,493	-$3,811	-$4,121
Commuting	-$1,646	-$1,913	-$1,986	-$1,835	-$1,920	-$2,132
Pollution abatement	-$155	-$156	-$156	-$163	-$159	-$152
Vehicle crashes	-$971	-$1,083	-$1,010	-$868	-$841	-$782
Water pollution	-$2	-$2	-$2	-$2	-$1	-$2
Air pollution	-$163	-$188	-$170	-$164	-$160	-$151
Noise pollution	-$94	-$81	-$77	-$77	-$77	-$77
Wetland services	$3,973	$3,702	$3,518	$3,403	$3,305	$3,195
Farmland services	$996	$595	$737	$677	$636	$595
Nonrenewable resources	-$2,152	-$2,205	-$2,363	-$2,208	-$2,232	-$2,304
Climate change	-$682	-$946	-$1,262	-$1,345	-$1,583	-$1,656
Ozone depletion	-$44	-$9	-$2	-$1	-$1	$0
Forest services	$7,030	$6,029	$5,297	$4,899	$4,621	$4,342
Desert services	$2,574	$2,231	$1,982	$1,845	$1,748	$1,649
Net capital growth	$401	$682	$1,690	$1,282	$1,267	$1,287
GPI	$25,192	$25,244	$27,743	$27,511	$28,181	$29,184

COUNTY LEVEL GPI RESULTS

In 2007, per-capita GPI values were the highest in Salt Lake and Washington counties and the lowest in Cache and Utah counties (Table 64and Figure 9). The low GPI values in Cache and Utah counties are primarily associated with low per-capita consumption. A summary of individual component values and costs for each county is available in Appendix A.

Washington and Cache counties are the only counties where GPI per capita declined since 1990 (Figure 10). This is largely due to the loss of leisure time, the increased cost of commuting, and a loss in wetland and forest ecosystem services associated with changes in land use. These declines were in part driven by population growth, which resulted in distribution of wetland and forest ecosystem services among more people. By contrast, the GPI for Davis and Weber counties steadily increased over the past two decades, with a slight decline in Davis County in recent years. There was a dramatic increase in income inequality in Davis County after 1995. The GPI for Salt Lake County increased faster than any other county since 1990 (Figure 10). This increase was driven by a sharp rise in personal consumption. Like other counties in Utah, social and environmental indicators in Salt Lake County are in decline. The counties included in this study represent 75% of the aggregate GPI for the entire State of Utah (Figure 11), which is driven largely by the concentration of population in the counties included in this study. Interestingly, during the 1990-2007 period per-capita GPI for the state (Utah GPI) was higher than most of the counties (with the recent exception of Salt Lake County) researched in this study (Table 64). This suggests that the highest GPI values may be found in rural parts of the state, which were not analyzed in detail for this study.

Table 64. GPI per-capita for Utah and six most populous counties (2000 USD)

	1990	1995	2000	2003	2005	2007
Cache County	$20,699	$18,365	$17,746	$16,663	$16,447	$16,739
Davis County	$14,743	$17,137	$20,899	$23,302	$22,445	$22,365
Salt Lake County	$15,616	$19,448	$25,160	$24,609	$28,343	$31,674
Utah County	$14,687	$15,924	$19,208	$17,880	$18,767	$19,849
Washington County	$27,580	$23,399	$24,204	$22,703	$22,049	$22,487
Weber County	$17,108	$17,765	$20,302	$21,567	$23,335	$25,071
State of Utah	$25,192	$25,244	$27,743	$27,511	$28,181	$29,184

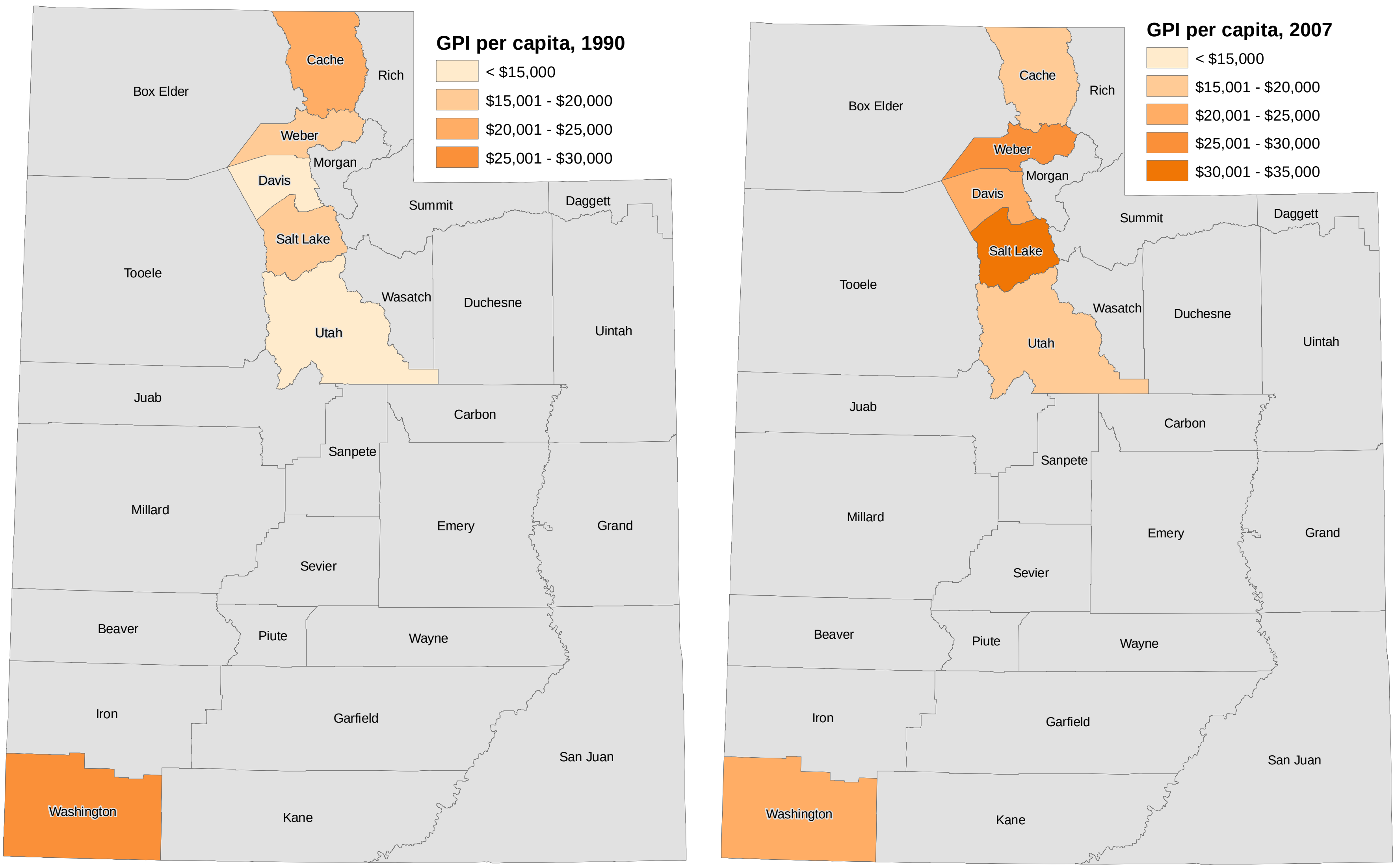


Figure 9. Change in GPI per-capita between 1990 and 2007 in Cache, Davis, Salt Lake, Utah, Washington, and Weber counties.

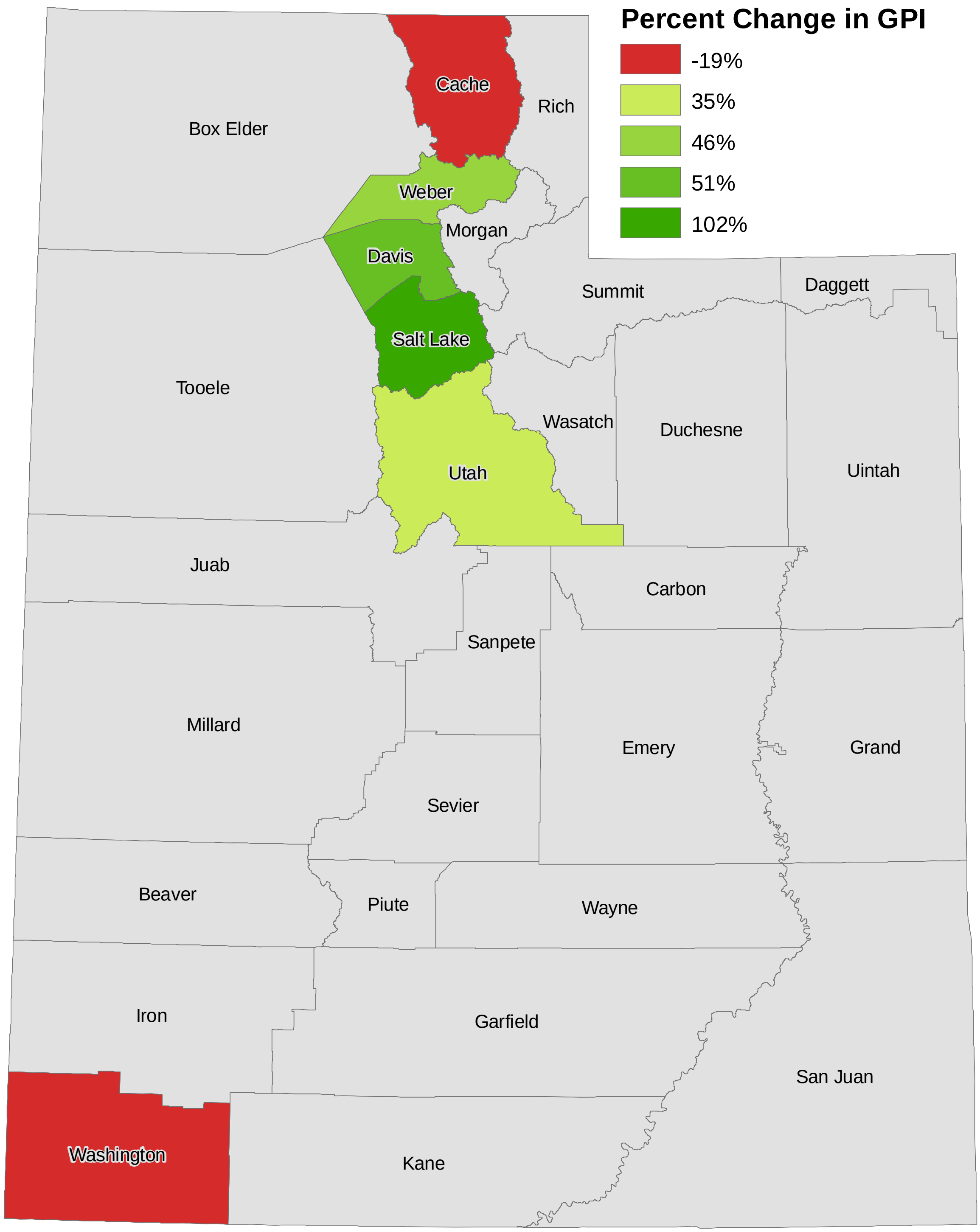


Figure 10. GPI per-capita percent change from 1990 to 2007 in six Utah counties.

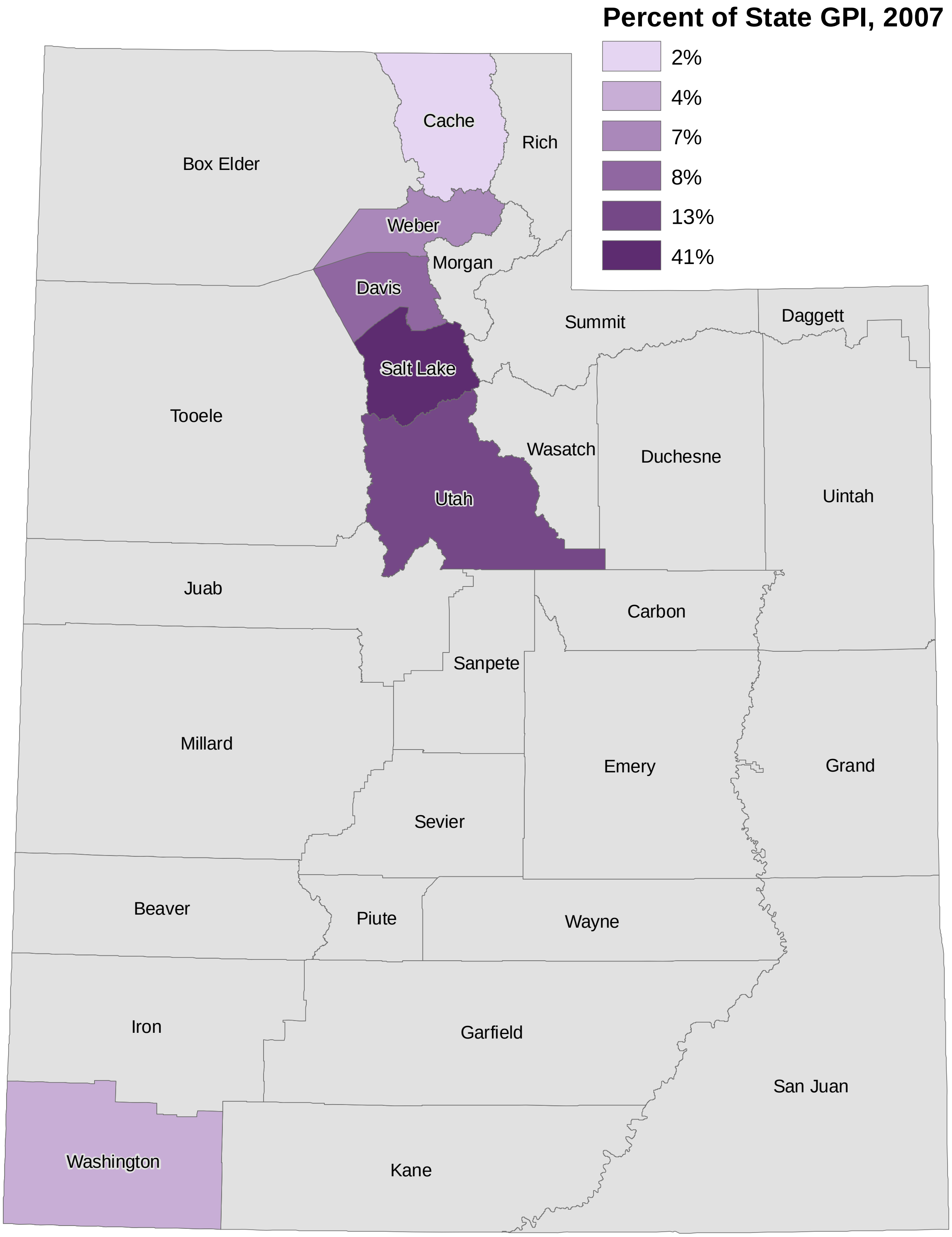


Figure 11. Contribution of six Utah counties to total GPI in Utah in 2007.

INTEGRATION WITH EARLIER STUDIES FOR UTAH

One of the primary goals of the Utah Vital Signs project is to incorporate multiple indicators in evaluating the trends in social, economic, and ecological systems that support our quality of life. In this section, we compare the GPI results to two other indicators for Utah: Ecological Footprint and subjective quality of life (Figure 12).

The UPEC completed the Ecological Footprint project in 2007 (McIntyre et al. 2007). The Ecological Footprint is an ecological accounting tool that compares a particular human demand (footprint) in a given year to the available biological capacity (ecological goods and services produced sustainably) in that year in units of global hectares (Figure 12). The results of this study indicate that Utah is currently living beyond its ecological means, i.e. drawing upon ecological resources supplied by other states or nations. Between 1990 and 2003, Utah went from an ecological surplus of 10.8 million global hectares to an ecological deficit of 2.4 million global hectares.

The quality-of-life metrics are reported in the *Utah Values and Future Growth* study sponsored by Envision Utah in 2007 (Envision Utah 2007). The study focuses on Utahns' quality of life as reported by residents, and as such, it is a study in subjective well-being or quality of life. The study compared results from 2007 to those from a study of 1996 in order to assess how our quality of life, as perceived by Utahns themselves, changed over time.

Figure 12 shows that as our Ecological Footprint increased Utah moved from an ecological surplus to an ecological deficit between 1990 and 2003. This change coincided with the rise in GDP per capita. This finding is also consistent with our overall GPI results, which indicate that economic components of GPI continued to increase since 1990, whereas the value of social and environmental components decreased since then. The environmental indicators included in the GPI generally trend downward consistent with the ecological surplus and deficit estimates from the Ecological Footprint study. Also, the decline in social and environmental components of GPI could have contributed to the reduced quality of life reported by Utahns in the Envision Utah study. Indeed, several of the largest costs to Utah's GPI (cost of lost leisure time, commuting, and vehicle crashes) are similar to those reported by Utahns in the *Utah Values and Futures Report* as the most important factors to Utah's quality of life (crowding, traffic, lack of diversity, and lack of affordable housing). Likewise, the largest positive values contributing to per-capita GPI in Utah are the value of household labor and ecosystem services, which are consistent with the factors reported by Utahns as the most important aspects of quality of life in Utah: a safe community with low crime, a sense of being close to family, and enjoyment of the outdoors and nature. Several factors that are not picked up by subjective quality of life measures but that are components of GPI include the value of ecosystem services (other than recreational enjoyment), cost of climate change, and the loss of nonrenewable resources. The negative impacts of these factors are difficult for individuals to observe on a short time frame, which may explain why Utahns did not express concern about them.

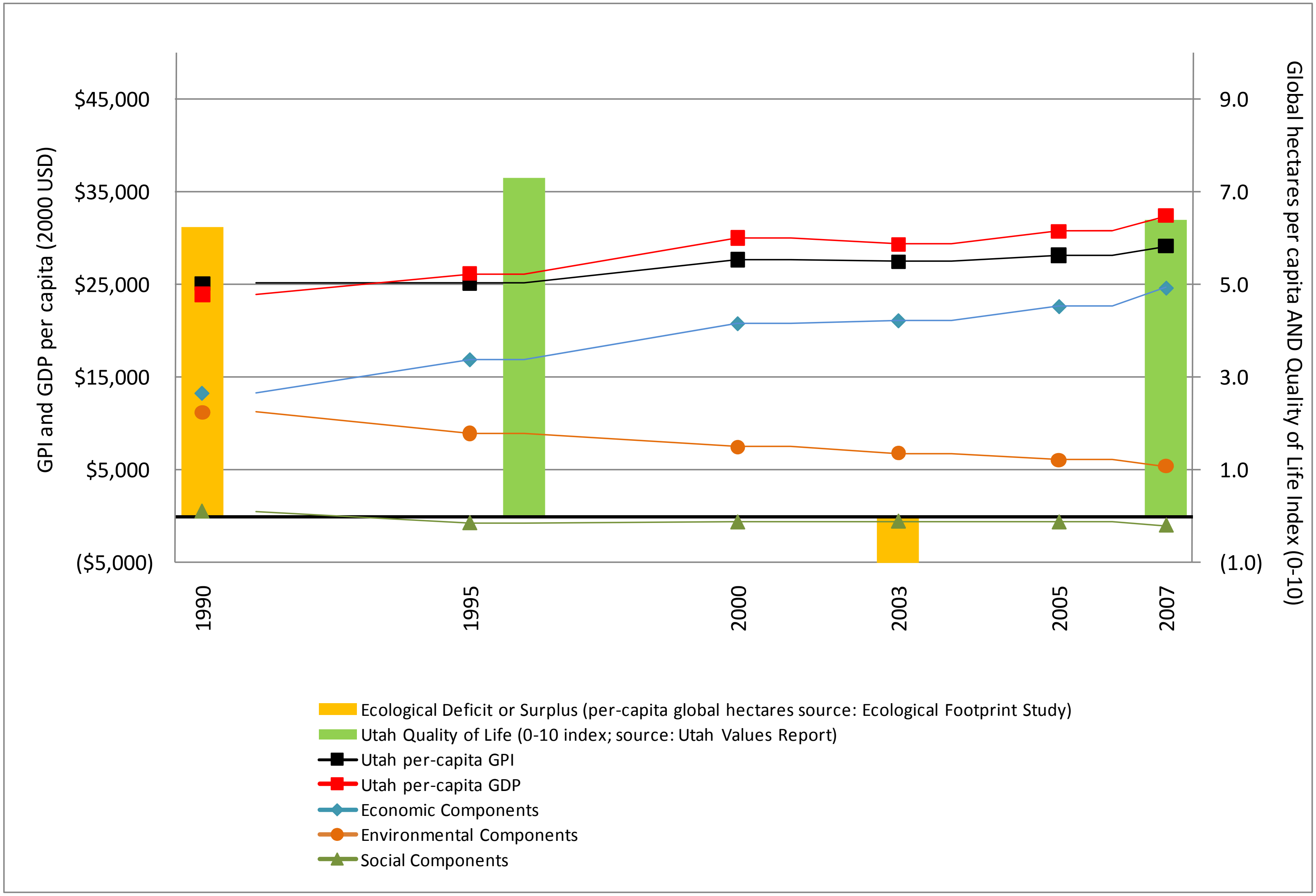


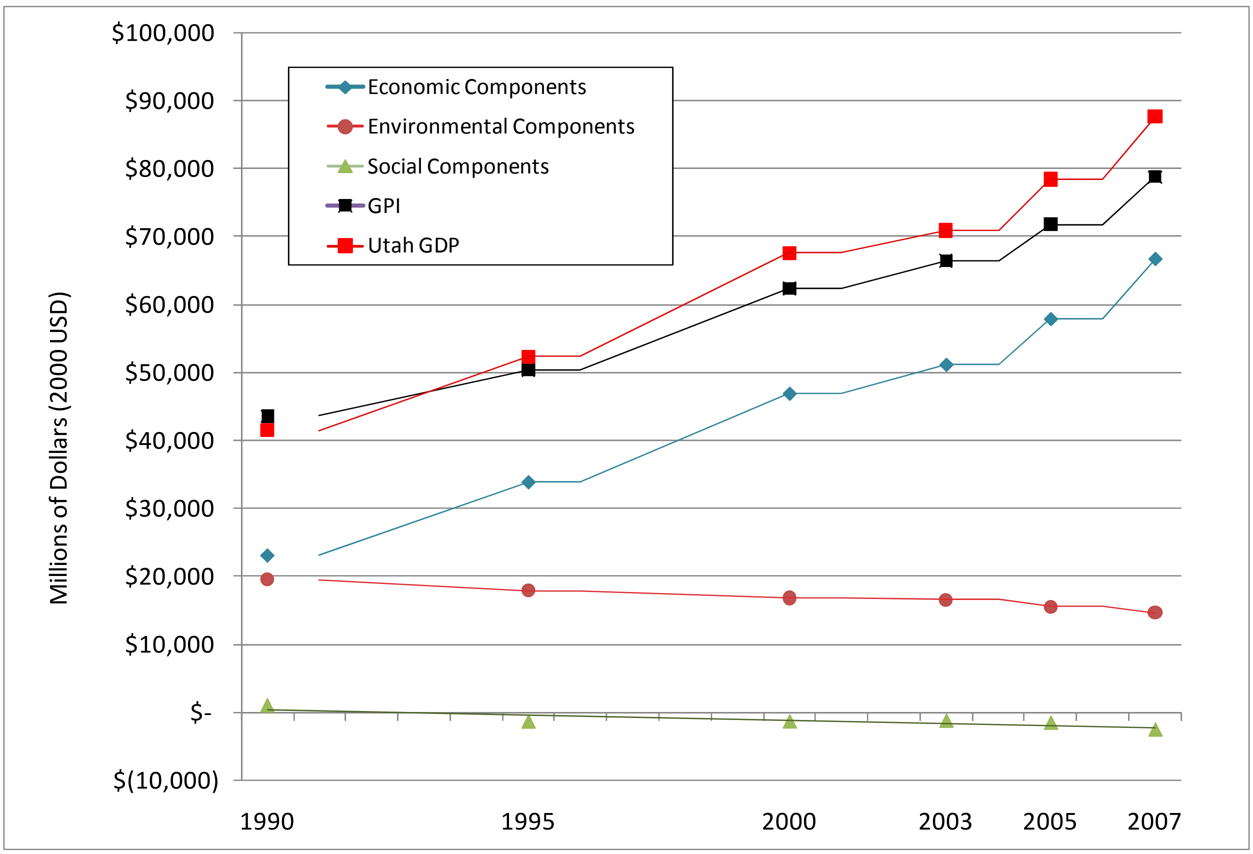
Figure 12. GPI per capita (2000 USD), ecological surplus or deficit per capita (global hectares), and quality of life (index) trends for Utah

HIGHLIGHTS OF THE UTAH GPI STUDY

UTAH HAS MADE GENUINE PROGRESS SINCE 1990

Between 1990 and 2007, the Utah's GPI increased, albeit at a slower rate than the GDP for Utah, which suggests that the state's GDP overstates the improvement in the well-being of Utahns. The starting point of GPI is personal consumption expenditures, which also is the largest component of GDP. However, beyond this, the GPI estimation includes a number of contributors to our well-being that are unrecognized by the GDP. Top contributors among these are unpaid household labor and the services provided by forests, wetlands, and deserts. Utahns' quality of life is reduced, on the other hand, by a number of costs that are also not accounted for in the GDP. Chief among these are the cost of depletion of the state's nonrenewable resources, lost leisure time, and cost of commuting.

In general, the economic components of GPI—chief among them personal consumption and net capital growth—were on the rise between 1990 and 2007. However, the value of both environmental and social components of GPI declined during the same period, offsetting part of the gain in the economic components.



VOLUNTEER AND HOUSEHOLD LABOR HAVE REAL VALUE FOR UTAH

Two major contributors to Utahns' quality of life are housework and volunteer work, neither of which is counted in the GDP because the work is unpaid.

Volunteer labor is unpaid labor that is important for supplementing services provisioned through the market. Volunteer labor also builds and strengthens social ties in a community. On average, Utahns volunteered 2.3 times the national volunteer hours between 2002 and 2008. This performance ranks Utah the first in the nation in terms of volunteer work. The value of volunteer labor in Utah in 2007 was $1.6 billion dollars, more than twice the value of $690 million in the state in 1990.

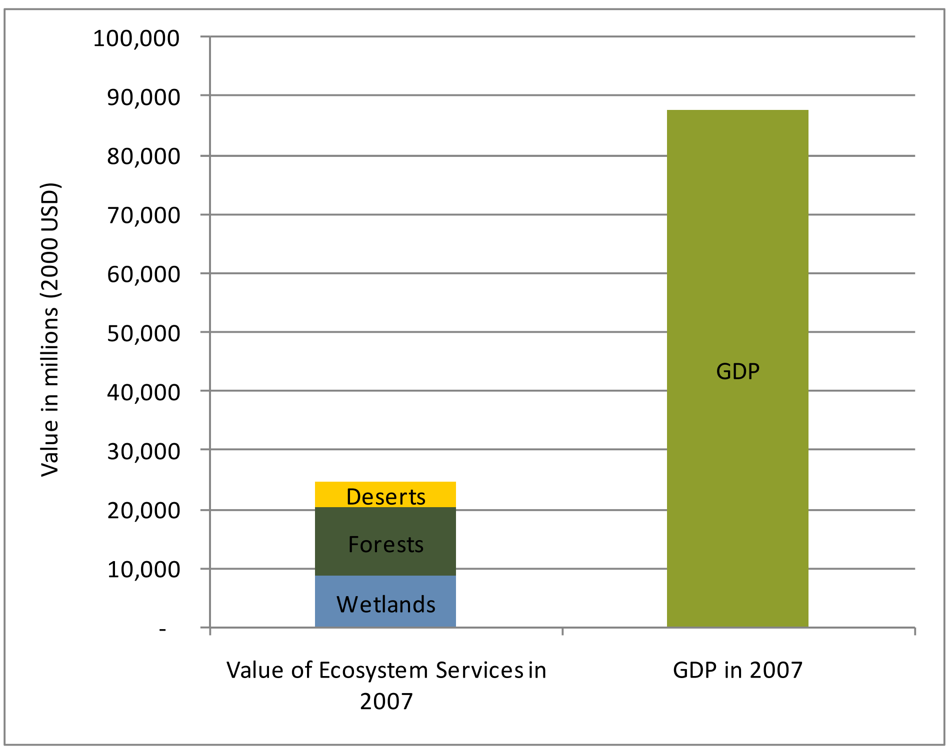
In 2007, the total monetary value of household labor performed in the state totaled $12.5 billion, up from $9.5 billion in 1990. To give an indication of the relative magnitude of the total monetary value of this unpaid set of activities we note that this sum amounted to 14 percent of Utah's GDP in 2007. Thus what is unnoticed in the GDP amounts to a substantial contribution to the well-being of Utahns. Consistent with the national trends, however, the amount of time the average Utahn spent on housework and care work declined. This decline largely reflects substitution of store-bought goods and market services for the unpaid services previously provided by family members as these market substitutes become more widely available and affordable. These changes indicate a shift in the locus of work from the household to the market and thus would be reflected as increase in personal consumption expenditures. That said, in 2007, in Utah women and men who were not in the labor force or were unemployed performed approximately 10% more household hours relative to the national average.

ECOSYSTEMS PROVIDED UTAHNS WITH $25 BILLION IN GOODS AND SERVICES IN 2007

Utah's wetlands, forests, and deserts provide valuable services to society, many of which are not valued in state (or national) income accounting. Ecosystem services are described in terms of provisioning services, regulating services, and cultural services. Provisioning and cultural services—also described as direct uses of ecosystems—include consumptive uses of food, timber, fiber, fuel, and medicinal products that are generally counted in the GDP. Nonconsumptive uses include cultural services such as recreation, aesthetics, heritage value, bird watching, and spiritual and social values that do not require harvesting products. Regulating services include water filtration, dust regulation (by plants that stabilize soils and reduce erosion), flood protection functions of wetlands, gas regulation (e.g., carbon sequestration and production of oxygen), processing of nutrients, and waste absorption and detoxification by wetlands, forests, and other ecosystems. For example, a forest provides a recurring flow of timber, erosion control, biogeochemical cycling, and clean water.

Environmental degradation and the losses of wetland, forest, and arid land ecosystems in Utah result in losses of these services that have real costs in terms of damage costs (e.g., loss of protection services), replacement cost (e.g., the need to replace water filtration capacity of forest systems with more highly engineered treatment systems and chemical treatment), and direct losses of commodities (e.g., productivity of agricultural land and rangeland or supply of timber from forests or fish from fresh waters). In some cases, values of these ecosystem services can only be estimated by asking people directly what they are willing to pay to preserve an ecosystem (i.e., willingness to pay or contingent valuation methods). All of these valuation methodologies (willingness to pay, replacement costs, and direct losses of commodities) are included in the valuation of Utah's wetlands, forests, and grasslands for this GPI study.

Wetlands are relatively rare in arid Utah, making wetland acreage even more valuable. Wetlands around the Great Salt Lake make up the majority of wetland acreage in the state and provide critical habitat for migratory bird species. Marshy meadows in the mountainous areas of Utah also perform an important regulatory function for water supply and water quality. The value of services provided by wetlands to Utahns in 2007 amounted to $8.6 billion. Utah forests provide the structure for diverse ecosystems and serve as important habitat for migratory songbirds and raptors, bats, and other wildlife. In addition, forests provide soil erosion control that protects pristine mountain streams and are heavily used for recreation. They also provide some timber and range for cattle. The total value of forest ecosystem services calculated for use in the GPI was $11.7 billion in 2007. Utah's desert grasslands and scrubland provide ecosystem goods and services to Utahns primarily through soil erosion control (dust regulation), recreation (hiking, camping, off-road vehicles, etc.), commodities (range for cattle), and habitat for wildlife. Near urban areas, on public lands, and on sites culturally valued by Native Americans, aesthetic, recreational, and cultural values for deserts are also large. In addition, deserts play an important role in oxidation of atmospheric methane, an important greenhouse gas. Finally, providing habitat for pollinators may be one of the greatest services that deserts and scrublands provide. Many Utah crops rely on this pollination including orchards and alfalfa. The total value of desert grasslands and scrublands was $4.5 billion in 2007.



LOSS OF PRIME FARMLAND REPRESENTS A SIGNIFICANT COST TO UTAH'S FUTURE

Agriculture has been an integral component of the Utah landscape at least since settlement by Mormon pioneers. Prime farmland is relatively scarce in the state. Today, the most common agricultural commodities grown in Utah are dairy, cattle, hay, hogs, and greenhouse products, with the majority of farms having less than 100 acres. The majority of cultivated crops are grown in valleys fed by mountain runoff.

In 2007, Utah had 1.8 million acres of cropped farmland, a reduction of 10% since 1987. This trend is relatively consistent across the state's most populous counties with the sharpest recent decline in Davis County and an increase in Washington County. The loss is primarily due to the expansion of commercial and residential developments, and represents a semi-permanent loss of prime farmland in many of Utah's most productive valleys. Utah will thus face not only reduced income from farmlands but also loss of the security of being able to grow food locally and sustainably in the future.

In this study, option values were used to estimate the value of food security for prime farmland in Utah. Option value is the value of preserving the option to use something in the future (e.g., preserving prime farmland for future use, even if the land is not currently being actively used for food production). The option value of these lands was valued at $436 to $1,910 dollars per acre per year (in 2000 USD) over and above the value of agricultural products produced from the land. In 2007, the cropland in Utah had an estimated option value of $1.6 billion (this excludes the value of crops grown, which are captured in the personal consumption component of GPI).

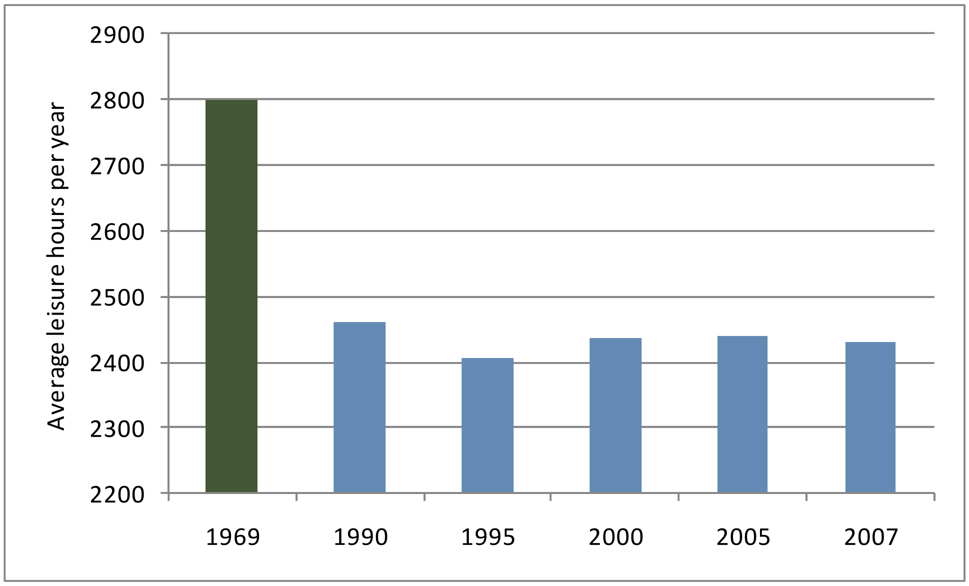
UTAHNS EXPERIENCED RISE IN BOTH OVERWORK AND UNDEREMPLOYMENT

By focusing only on market transactions GDP fails to account for the contributions of free time to our well-being. Thus the time-use patterns, such as overwork and decline in leisure, that underlie our increased personal consumption expenditures are unaccounted for in the GDP.

Overwork and underemployment increasingly coexist in the U.S., and Utah is no exception. Utah workers who were employed full-time worked a modest amount more annually in 2007 than in 1990 (2,263 hours in 1990 v. 2,297 in 2007). At the same time, there was an increase in the number of workers who are considered underemployed—those who are employed part-time but would like to work full-time.

Underemployment and long-term unemployment undermine quality of life because they contribute to social exclusion, undermine cohesion of communities, and contribute to frustrations that may lead to a variety of social problems. The period covered by the study was one of low unemployment and underemployment rates, nationally and in Utah. Utah had even lower unemployment rates than the nation as a whole. Compared to full-time, full-year workers, the underemployed workers provide far fewer hours in the labor market. These "unprovided" hours of the underemployed in Utah increased between 1990 and 2007. The cost to society of underemployment and unemployment peaked at $2.1 billion in 2003 and stood at $1.7 billion in 2007.

While the underemployed enjoy “forced” leisure, the fully-employed workers experience rise in overwork that is also captured by the loss of leisure time for this group. When hours performed in the labor market are combined with unpaid household labor hours, the fully-employed workers in Utah performed between 3,014 and 3,069 hours of work per year during the study period. Assuming a total of 5,475 hours available for work and play in a given year, this implies Utah’s fully employed workers had 2,400 to 2,460 hours of leisure per year during the study period. Compared to the peak leisure hours experienced by the average fully-employed worker in the US in 1969 (2,800), the fully-employed worker in Utah had 339 hours less leisure time in 1990 and this leisure gap widened over the study period to 369 hours. The estimated cost of lost leisure hours nearly doubled from $3.2 billion to $6 billion between 1990 and 2007.

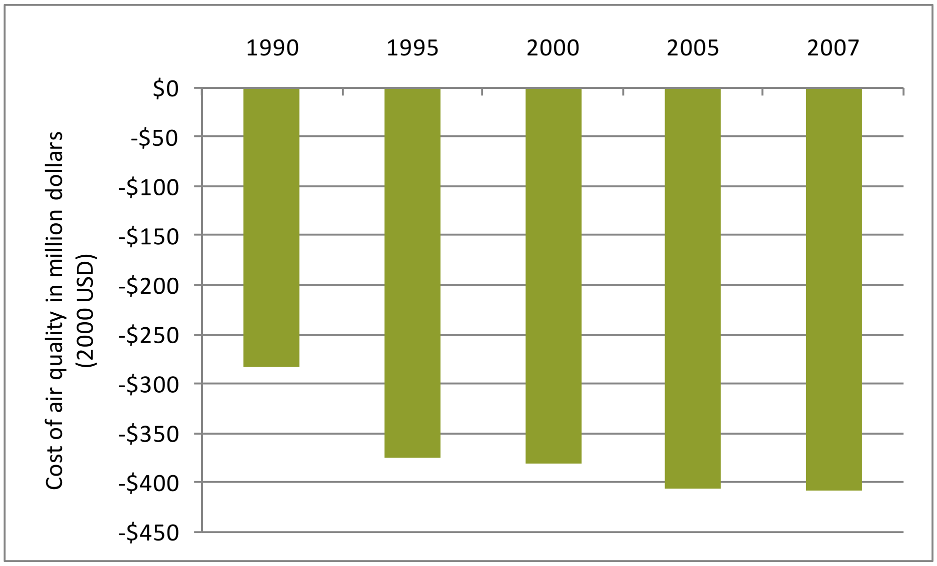


UTAH HAS MADE PROGRESS IN REDUCING POLLUTION: MORE IS NEEDED TO COMPENSATE FOR POPULATION GROWTH

Utah has made progress in reducing water pollution and air pollution, but the increasing population in Utah threatens these gains and requires renewed efforts to continue to reduce our individual, municipal, and industrial contributions to pollution. More people in our communities represent a greater potential for pollution emissions but also mean that more people are impacted by poor air and water quality. The one form of pollution that has continued to increase across the state is noise pollution, especially in urbanized areas of the state.

Clean water in Utah’s streams, lakes, and rivers provides clean drinking water, healthy fisheries, safe and enjoyable recreation, aesthetics, increased property values and healthy aquatic life. Polluted water results in many costs including increased costs of treating drinking water, losses to tourism and recreation revenue, costs associated with the loss of fisheries, reduced property values and the loss of aquatic life and habitats that depend on clean water. Since 1972, the quality of fresh waters in the US and Utah has improved in large part due to the widespread implementation of secondary and tertiary wastewater treatment systems, as required under the Clean Water Act. Between 1990 and 2007 the estimated total costs associated with water quality impairments in Utah have fluctuated between $3.2 million and $4.9 million.

Air quality impacts society most directly through human health. Poor air quality has been linked to decreases in lung function, increases in heart attacks, and increases in the severity and frequency of asthma. Other costs associated with air pollution include loss of visibility associated with haze and particulate matter. Air quality in Utah is of greatest concern in valley areas that experience temperature inversions associated with topography. During inversions, the Wasatch Front and Cache Valley often record the worst air quality in the country. Despite the challenges associated with topography, Utah has significantly cleaner air today compared to monitored concentrations in the 1980s. Reductions in emissions since then, primarily in motor vehicle and industrial emissions, have resulted in improved air quality and visibility throughout the state. Nonetheless, counties along the Wasatch Front have not been able to attain National Ambient Air Quality Standards (NAAQS) established by the EPA and regulated by the Utah Department of Environmental Quality. Total cost of damages associated with air quality in the state increased from $210 million in 1990 to $409 million in 2007. Salt Lake County accounts for nearly half of the statewide damage costs, in large part due to the topography and population affected in the area. This is a conservative estimate of the costs of air quality that only partially accounts for Utah's unique topography and does not account for any reduced economic development opportunities associated with companies choosing to relocate in other cities due to poor air quality in Utah's metropolitan areas.

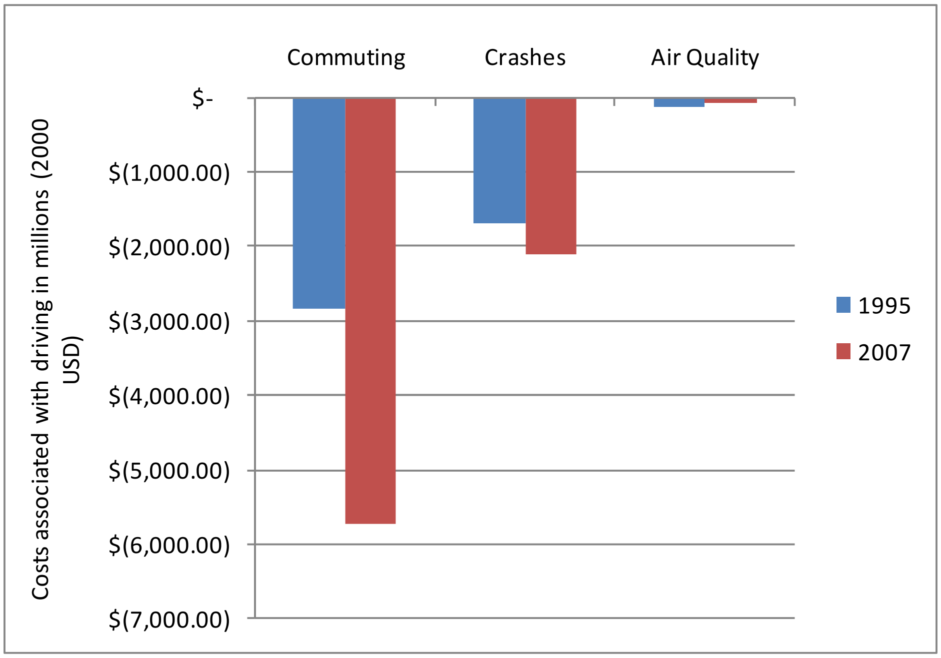


Noise pollution disrupts sleep, recreation, and general well-being. Loud and repeated noises often are the most disturbing. Not only does noise impact the enjoyment associated with our environments but also it can undermine human health. The total cost of noise pollution in Utah increased steadily from $162 million in 1990 to $209 million in 2007 as a result of the urbanization experienced around the state. The largest costs of noise pollution are found in Salt Lake County, the most urbanized county in the state.

It costs us to dispose of our waste or to reduce the pollution we create. Three costs enter the daily lives of most Utahns: We pay for automobile emissions abatement, wastewater treatment (municipal sewage and septic), and solid waste (garbage) disposal. We refer to these as household pollution abatement costs. Since 1990, the amount of municipal garbage Utahns generated has risen steadily with population growth and increased personal consumption. The amount of garbage generated per person rose in the 1990s and peaked in 2003. The total cost of household pollution abatement increased from $268 million in 1990 to $411 million in 2007. The majority of the cost is associated with wastewater treatment, followed by solid waste disposal, and auto emissions abatement.

SOCIAL AND ENVIRONMENTAL COSTS ASSOCIATED WITH DRIVING ARE SUBSTANTIAL AND RISING

Commuting costs include the expense of owning and operating a vehicle, loss of time available for other activities, and public transit expenditures. The commute time per commuter in Utah increased from 158 hours in 1990 to 178 hours in 2007. The expense and time cost of driving for Utahns was $5.8 billion in 2007, up from $2.8 billion dollars in 1990. In addition to these commuting costs, driving also carries the risk of accidents and contributes to air pollution. In 2007, vehicle crashes in Utah cost $2.1 billion in terms of property damage and healthcare expenses as well as the value of lost life and lost wages associated with injury and death. In addition, emissions of air pollutants from cars accounted for $69 million of air quality costs in Utah in 2007 (a reduction in costs associated with mobile sources since 1990). Thus the total cost of driving in Utah in terms of commuting, vehicle accidents, and reduced air quality was $7.9 billion in 2007, more than double the cost of driving in 1990 of $3.2 billion.



UTAH HAS MADE GOOD PROGRESS TOWARDS REDUCING CRIME, DIVORCE, AND AUTOMOBILE ACCIDENTS

The cost of crime is borne by potential or actual victims of crime, by government in the form of police services and by businesses through hiring of security guards. The peak year for incidents for most types of crime in Utah was 1995, after which the crime rates and the per capita cost of crime decreased. While the direct cost of crime constitutes the larger component of the total cost of crime, defensive (indirect) expenditures by households to prevent the erosion of safety rose faster than the direct cost of crime over the 1990–2007 period.

Divorce has negative costs to individuals associated with legal fees, setting up separate households, and impacts to children affected by divorce. While the total number of divorces in Utah increased until 2005, the divorce rate (divorces per 1000 people) steadily declined since 1990. Divorce cost Utahns $234 million in 2007, down from $258 million in 1990.

There has been a steady decline in crashes in Utah resulting in injury or death since 1970 due to traffic safety programs, seatbelt usage, aggressive media and enforcement programs targeting driver behavior, improved roadways, improved vehicle safety, and advancements in emergency response. Utah's traffic fatality rate has been lower than the U.S. rate since 2001. Nonetheless, total vehicle crashes in Utah reached a low of 50,389 in 2003 and increased since then to 61,245 crashes in 2007. While the total costs associated with vehicle crashes in Utah rose from $1.7 billion in 1990 to $2.1 billion in 2007, the per capita cost in Utah decreased steadily from $971 in 1995 to $782 in 2007, reflecting the reduced crash rate (crashes per 1000 people).

PERMANENT DEPLETION OF NONREWABLE RESOURCES IS A SIGNIFICANT LOSS OF WEALTH TO UTAHNS

GPI includes an estimate for the depletion of natural capital in order to assess the sustainability of income and consumption levels in the future. The depletion of nonrenewable resources in Utah such as coal, natural gas, and oil results in a net loss of wealth to Utah and is a source of income that cannot be sustained into the future. This loss of wealth is measured as the cost to replace these resources with renewable energy sources. While the present levels of resource extraction can be sustained for some time, without depletion or sharp rise in resource prices, in the replacement cost approach the actual cost of establishing a renewable resource substitute is attributed to the point in time when the depletion takes place. We included only those depletions associated with consumption by Utahns in our calculation because personal consumption is our starting point and deducing the loss of resources consumed by energy customers outside of Utah would be an overestimate of the impact on Utahns today. The permanent loss of natural resources is the largest deduction for Utah's GPI and amounted to $6.2 billion in 2007. This is a conservative estimate as it does not include the loss of minerals, metals, and other nonrenewable natural resource losses.

STUDY IMPLICATIONS: TRACKING OUR PROGRESS

The Utah GPI study shows that Utahns experienced improvements in quality of life in the 1990-2007 period. The aggregate Utah GPI increased since 1990. However, the growth rate was slower than the state's GDP, which indicates that the state GDP overstates the improvement in the well-being of Utahns. While the economic components of GPI were on the rise, driven upward by personal consumption expenditures, societal and environmental components of GPI trended downward. Underlying these trends are the increasing costs and decreasing values associated with social and environmental components that contribute to our quality of life. The study shows that social and environmental factors affecting quality of life might require attention and investment.

The study demonstrates that tools can be developed and used to provide a more useful measure of progress in a state than the GDP. Social and environmental factors can be combined with economic factors in an integrated and transparent framework to arrive at an assessment of general progress and quality of life in Utah. This framework can be used to provide a snapshot of quality of life in a given year and to track its various dimensions over time in monetary as well as physical (nonmonetary) terms.

The GPI accounts can be adopted by the state government and/or other public/private institutions so as to track actual progress for Utahns at the state and county levels. The state government is best suited to maintain indicators such as the GPI, given the data-intensive nature of the measure. Various government agencies, coordinated by one department, such as the Governor's Office of Planning and Budget, could best contribute the information in their respective areas of expertise to undertake annual updates for inclusion in the GPI. A web-based tool similar to the one used by the State of Maryland (State of Maryland 2010) could be developed to report changes in the GPI and its components to Utahns.

In addition, the GPI results provide substantial opportunity for local policy makers to make informed policy choices that take into consideration a broad range of factors beyond the economic indicators. The GPI framework fits in well with other values-driven planning processes, such as the activities of Envision Utah or the Quality Growth Commission, which seek to shape the course of economic development in the state. The transparent and integrated framework of GPI can be used to guide budget and planning in the state and its counties, allowing decision-makers to examine the trade-offs in using resources and assessing well-being outcomes of policy. For example, components of the GPI, such as the cost of vehicle accidents, commuting time, air pollution, and the loss of open space, could inform transportation planning. Because the results are reported in uniform monetary units, they can be used to directly assess economic tradeoffs. Furthermore, GPI accounts can be aligned with existing state government performance assessment tools to estimate the quality of life impacts of public policy or budgetary decisions. While many of these impacts may not be discernible for a number of years, by insisting on full accounting of costs and benefits the GPI framework provides a suitable tool for assessing the full and long-term impacts of public policy and budget decisions.

CAUTIONARY NOTES IN USING THIS REPORT

CRITICISMS OF THE GPI

The GPI has been subject to critique on a number of grounds, most of which involve the decisions on the choice of components and the methods used in calculating these components. In particular, the valuation methods used in a number of components—that is, the choice of prices to assign in calculating the monetary cost or benefit of an item—have been subject to debate. The recent debates on the problematic aspects of GPI, the proposed solutions, and future improvements that are deemed necessary are reflected in Neumayer (1999); Dietz and Neumayer (2006); Lawn (2003); Lawn (2005); Clarke (2007); and Talberth et al. (2007). The current consensus is that the GPI is a valuable indicator of current economic welfare, and its value and widespread use would be enhanced through greater development of its valuation methods and consistency in their use. The main strength of GPI is that it provides a transparent, integrated accounting framework that allows for estimation of the full benefits and costs of our economic process and that it is open to improvement and modification over time (Anielski 2001).

ASSUMPTIONS INHERENT IN THE GPI

PERSONAL CONSUMPTION IS A NET POSITIVE

The GPI methodology uses personal consumption as the starting point for the analysis. Personal consumption expenditures include all types of spending by households to enhance their material well-being. This starting point assumes that consumption represents an individual's ability to improve their own well-being. Although the ability to acquire clothing, shelter, food, and health care do indeed contribute to well-being, there is a threshold after which personal consumption does not necessarily contribute to improved well-being (Jackson and Marks 1999). Overconsumption may even reduce well-being (e.g., due to obesity, diabetes, heart disease, and excess material things to manage) and is also one of the primary drivers of the unsustainable use of the earth's resources. Likewise, personal consumption includes costs of fighting ill health, which may be caused by unhealthy consumption patterns (e.g., excessive consumption of meat, sugar, alcohol, tobacco) or deterioration of environmental quality. However, the GPI methodology does not identify such a threshold consumption level, and U.S. GPI studies do not attempt to exclude certain types of consumption spending. Instead, GPI studies recognize that personal consumption creates some unaccounted costs, which need to be deducted. Thus the GPI captures some of the impacts associated with consumption (e.g., pollution, loss of ecosystem services) as its components. In the Utah study, in addition to these negative impacts we deducted a portion of the consumption spending on items of questionable value as contributors to individual well-being—alcohol, cigarettes, and junk food. We made this adjustment because we believe that the cost of ill-health-producing consumption belongs in any assessment of well-being. We made the deduction at the outset, as an adjustment to personal consumption expenditures. The alternative to this approach is to deduct a portion of the health expenditures by households from the GPI, on the assumption that this spending is generated to address the adverse health effects of consumption on these items of questionable value.

GOVERNMENT SPENDING

According to the GPI framework, public expenditures that are nondefensive in nature and that add to consumption of the population are included in the GPI income statement. On the other hand, public expenditures that are defensive in nature (i.e. that protect against increasing insecurity or erosions in quality of life and declines in capital values) or are investments in capital are excluded from the GPI. Thus, part, none, or all of public consumption expenditures (and the annual value of the services from capital stocks) are included in the GPI income statement, while public investments in human, social, and natural capital stocks and spending on public order and safety services (e.g. the military or police services) are excluded.

That said, GPI studies have varied in their treatment of government spending. Daly and Cobb (1989) included a percentage of public expenditure on higher education and healthcare as additions to well-being, while recent U.S. GPI studies have not included these categories of spending. The GPI studies for Australia and Austria included at least a portion of public expenditure in the GPI (Lawn and Sanders 1999; Stockhammer et al. 1997). In the Alberta (Canada) GPI study, Anielski et al. (2001) and Anielski (2001) used a systematic framework for identifying government expenditures for inclusion in the GPI. The Alberta GPI study excludes expenditures on public education from the GPI since this spending is an investment to enhance skills, but adds as additions to well-being 50% each of spending on public health, public transportation and communication, and 25% of public order and safety and social services expenditures (Anielski 2001). In the Utah GPI, government spending is reflected in three forms:

1. Transfer payments, in the form of social security checks, unemployment insurance, and other forms of social safety-net income that are spent on consumer goods and services are reflected in personal consumption expenditures. Transfer payments are not government expenditure in the sense of payments by government agencies in exchange for delivery of goods and services. In 2007 these payments accounted for about two-thirds of federal government budget outlays (Landefeld et al. 2008).

2. When state and local government agencies provide services for a fee (e.g., water, sewer, or transit systems) in a manner similar to private business, these fees are included as part of the consumption spending by households. Tuition payments in higher education also pay for at least a portion of the higher education services provided by state governments and thus are included in personal consumption expenditures.

3. A large part of government expenditure represents additions to built capital that yields services in future years. In keeping with the distinction between current income and capital stock, GPI includes only the annual services derived from these investments. In the current GPI methodology that we adopted, of the public investments, we only included the annual services provided by streets and highways. These are services that the public does not pay for in the form of fees or tolls, hence their services are not reflected in personal consumption expenditures. We approximate the annual service value of streets and highways in terms of their annual depreciation value.

The Utah GPI study thus does not include a number of categories of state and local expenditures that add to current consumption of Utahns, such as parks, recreation and culture expenditures or a portion of public health expenditures that provide services at either subsidized rates or free of charge. In order to achieve a more complete assessment of well-being, future Utah GPI studies could conduct a systematic evaluation of Utah state budget and apply the methodology of the Alberta study to integrate public spending in the GPI accounts.

SUBJECTIVE DETERMINATION OF COMPONENTS OF GPI

Although we refer to the GPI as an objective metric, the calculation of GPI involves many decisions that are or could be subject to debate. These decisions involve how to measure various components of GPI (which dimensions to measure and the choice of methodology). Such assumptions are not new or unique to the GPI; a similar debate surrounded the initial development of GDP (Kuznets 1941). In the case of GPI, the concept of family breakdown, for example, might be measured in different ways. Our methodology, and the one relied upon by other U.S. GPI studies, operationalizes this concept in terms of two aspects of family life: 1) the intactness of marriage and 2) the amount of time a family with children spends watching TV. These measures are proxies for quality of family life, but there could be other proxies instead of or in addition to these.

Some of the dollar values attached to various time, resource, and other inputs also involve value judgments. For example, should the value of an hour spent commuting be the same value as an hour spent doing yard work in one's own backyard or an hour watching TV? If different, how much should each reasonably differ from one another? The Utah study closely follows the choices made in national and local GPI studies and explains these decisions in discussion of each dimension of GPI. The decisions in this study were based on best professional judgment after reviewing relevant literature and former GPI studies. Many of the decisions that were deemed "subjective" were agreed upon in consultation with the GPI technical advisory committee.

CHALLENGES OF APPLYING GENUINE PROGRESS INDICATOR AT LOCAL SCALES

The GPI methodologies were initially developed for national level assessments, where aggregate data are available over a longer period of time. Nonetheless, there is a growing interest in applying GPI methods at the state, county, and regional scales due to the impact that local policies can have on well-being. To date, local GPI studies in the U.S. have been completed in Vermont (Costanza et al. 2004), Ohio (Bagstad and Shammin 2009), Minnesota (Minnesota Planning Environmental Quality Board 2000), the San Francisco Bay Area (Venetoulis and Cobb 2004), Maryland (State of Maryland, 2010), Michigan (Michigan State University), and the Northern Forest (Bagstad and Ceroni 2007). There is also an effort in progress in Massachusetts (Assumption College) to complete state-level GPI studies.

There are three key challenges associated with applying GPI at local scales (i.e., at the regional, state, and county levels): 1) data availability and quality; 2) scaling of certain components; and 3) incorporation of transboundary costs and benefits (i.e., impacts emanating from other counties or states) (Bagstad and Ceroni 2007).

Data availability and quality is a concern for all GPI studies, but it can be particularly problematic at the county level. GPI components rely on trend data on quantities for the component of interest as well as valuation data (i.e., a unit price) to estimate the monetary value of that component. For example, estimating the contribution of household labor to GPI entails estimating both the hours of housework and care work performed, and assigning an appropriate wage to each hour. Although data availability and applicability is an issue for both types of data, perhaps the largest data gap for local GPI studies is in identifying locally appropriate valuation data. We derived the valuation data used in most GPI components from national-level valuation studies or from valuation studies in other regions. For example, we derived valuation of Utah's land-cover classes from a regional study applicable to the Western U.S. Air quality damages were obtained from a national-level study applied at the county level (Muller et al. 2011; Muller and Mendelsohn 2007). Most other valuation data come from national-level valuation studies. Trend data specific to GPI components (e.g., crime rate, land-cover change, water pollution) are typically available at the state level but may not be available at the county level or not available for each year. This requires researchers to scale unit values based on overall state data. In cases where state-level data are not available, we scaled trend data down from national averages based on population. It is important to note that government-collected and commercial data availability is improving at the national, state, and local scales (Bagstad and Ceroni 2007). Also, as the body of non-market valuation literature grows, local level GPI studies will improve. That said, it may not be possible to estimate some national-level GPI components at the state or county level due to lack of data disaggregated at these levels.

Transboundary costs and benefits are particularly problematic in local GPI studies. Consumption in one county may impact natural capital (forests, wetlands, etc.) in another county. Other spatial impacts, such as pollution traveling from one state to another may be captured in the GPI, but is not a problem over which local decision makers have much control (Bagstad and Ceroni 2007). For example, Salt Lake County may receive dust blown into the area from counties in Western Utah or from Nevada. Specifically, there is some concern that decisions in Nevada to withdraw groundwater from Snake Valley could reduce plant coverage and thus increase dust yield from Western Utah and further degrade air quality along the Wasatch Front. Although the costs to Wasatch Front counties would be captured by a local GPI, they are not directly related to either consumption patterns or policies in Salt Lake County itself.

FACTORS IMPORTANT TO UTAH NOT CAPTURED BY GPI

There are several future adjustments to make in the methodology and valuation of components of GPI. Some entail overcoming data limitations at the state level, other changes involve updating the methodology in light of more recent scholarship. Among these future adjustments are systematic evaluation of state and federal expenditures with a view to achieving a more complete accounting of the contributions of these expenditures to the well-being of Utahns.

Other factors that are important to Utah but not captured by GPI include:

1. **Water scarcity costs/value of water resources** is an issue of great concern to Utahns both now and historically. As population continues to grow, the water available for irrigation, municipal use, and as aquatic habitat will continue to dwindle. These losses could have profound impacts on our way of life in addition to our quality of life.
2. The **depletion of nonrenewable resources**, for example ongoing mining activity, represents a permanent loss of wealth from Utah, much like the nonrenewable energy calculations incorporated into the GPI study. The value of this lost wealth could not be determined for this GPI study.
3. **Importation of hazardous and/or radioactive wastes** is an issue of growing interest and concern to many Utahns. Although the import of wastes from other states would bring revenue to Utah, the risks and costs of housing this waste have not been well characterized in terms of economic, social, and/or ecological losses. Future GPI studies would benefit from a complete valuation of these impacts.
4. **Public lands management** has direct and indirect effects on the economic return associated with public land tourism and development. Likewise, public lands management also impacts the health and therefore value of ecosystem services provided by the lands. Values associated with public land management, as described in BLM Resource Management Plans, USFS Forest Management Plans, and other planning documents, could be included in a future GPI. Although we evaluated changes in quantity of ecosystems in Utah, we did not evaluate changes in the quality of these systems, which would be reflective of land management.

DATA LIMITATIONS AND IDENTIFIED GAPS

As an addendum to the detailed descriptions of the GPI methodology of the report, we describe some of the data limitations and data gaps identified during our research. The methods and values that we used need refinement based on future scholarship and better data availability.

1. **Valuation studies specific to Utah:** Some of the unit value data we used for the Utah GPI are based on literature from other regions and/or are outdated. The value of clean water, especially, is dated to a national-level study from 1982. Recent Utah-specific valuation studies for Utah's social and environmental resources are an important data gap to be filled by future GPI studies. The Utah Department of Environmental Quality is currently undertaking a study to evaluate the costs and benefits of new nutrient water-quality criteria and their effects on specific beneficial uses around Utah.

2. **Wastewater treatment and septic tank data:** The data for the population serviced by sewers do not match with overall population data for some parts of Utah. A refined dataset would improve the calculations of household pollution abatement costs.

3. **Noise pollution:** Noise pollution data are not available for Utah and were instead estimated based on an urbanization index. The costs of noise pollution were scaled from a 1972 estimate for the U.S. of $4 billion. Utah-specific noise pollution data would improve the calculations for this component substantially.

4. **Land-use change data:** The land-use change data we used for the study represent change from 1990 to 2001. We could not find more recent land-use change data that had coverage across the state of Utah. As a result, land-use change for wetlands, forests, and deserts after 2001 is extrapolated based on the rate of change in the 1990s.

5. **Defensive expenditures and opportunity costs of lost economic development associated with poor air quality:** We were not able to obtain statistics or estimates of consumer expenditures associated with poor air quality, such as the purchase of in-home air filters or leaving town during bad inversion spells. Nonetheless, these costs may be important components of GPI, especially for communities along the Wasatch Front. Nor were we able to quantify any impacts to economic development associated with the reputation of Utah's metropolitan areas having the worst air quality in the country during winter inversions.

6. **Municipal waste:** It would be preferable to separate construction and demolition waste from municipal waste. Some counties report these waste streams individually, others do not separate these waste streams in their statistics, and some report a construction and demolition value that is not believed to be comprehensive (UDSWH 2007).

7. **Ecosystem services valuation:** Our ecosystem services values are based on total acreage, but they do not incorporate any metric of quality that may have declined or improved over time with grazing pressure, invasive species, and wildlife management. These concerns are particularly relevant for the grassland land use.

ACRONYMS

AFEAS	Alternative Fluorocarbons Environmental Acceptability Study
ATUS	American Time Use Survey
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CDC	Centers for Disease Control and Prevention
CPS	Current Population Survey
EIA	U.S. Energy Information Administration
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute
GDP	gross domestic product
GPI	Genuine Progress Indicator
HDI	Human Development Index
ISEW	Index of Sustainable Economic Welfare
MEW	Measure of Economic Welfare
NAAQS	National Ambient Air Quality Standards
NIPA	National Income and Products Alliance
NLCD-LCCR	National Land Cover Database: Land Cover Change Report
SWReGAP	Southwest Regional Gap Analysis Project
TMDL	total maximum daily load
UDAQ	Utah Division of Air Quality
UDOT	Utah Department of Transportation
UDPS	Utah Division of Public Safety
UDSHW	Utah Division of Solid and Hazardous Waste
UDWQ	Utah Division of Water Quality
UNDP	United Nations Development Programme
UPEC	Utah Population and Environment Coalition
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VMT	Vehicle miles traveled
WHALE	Wellness Health and Lifestyle Education Center
WWF	World Wildlife Fund

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APPENDIX A. DETAILED GPI RESULTS AT THE COUNTY LEVEL

Table 65. Summary of GPI per-capita Results for Cache County, Utah (2000 USD)

	1990	1995	2000	2003	2005	2007
Personal consumption	$11,424	$11,991	$12,587	$13,296	$13,902	$13,371
Income inequality	$567	$59	-$476	-$927	-$1,274	$301
Personal consumption adjusted for income inequality	$11,991	$12,051	$12,111	$12,370	$12,628	$13,671
Household labor	$5,078	$4,865	$4,793	$4,517	$4,311	$4,559
Volunteer labor	$439	$423	$419	$503	$581	$538
Services of consumer durables	$1,781	$1,855	$2,012	$2,080	$2,157	$2,216
Streets and Highways	$346	$315	$359	$354	$420	$533
Crime	-$93	-$103	-$102	-$74	-$72	-$77
Family breakdown	-$248	-$219	-$199	-$193	-$174	-$192
Leisure time lost	-$1,582	-$2,083	-$1,997	-$1,808	-$1,853	-$2,155
Underemployment	-$336	-$432	-$454	-$805	-$669	-$578
Cost of consumer durables	-$1,522	-$1,760	-$2,561	-$2,965	-$3,235	-$3,499
Commuting	-$1,272	-$1,452	-$1,542	-$1,515	-$1,588	-$1,815
Pollution abatement	-$111	-$120	-$129	-$132	-$127	-$121
Vehicle crashes	-$950	-$958	-$865	-$740	-$629	-$608
Water pollution	-$2	-$2	-$3	-$3	-$1	-$1
Air pollution	-$85	-$99	-$97	-$69	-$72	-$65
Noise pollution	-$94	-$78	-$73	-$73	-$73	-$73
Wetland services	$4,198	$3,710	$3,406	$3,239	$3,103	$2,978
Farmland services	$1,078	$882	$747	$677	$627	$582
Nonrenewable resources	-$1,815	-$1,846	-$1,989	-$1,869	-$1,890	-$1,964
Climate change	-$972	-$1,129	-$1,233	-$1,342	-$1,323	-$1,384
Ozone depletion	-$44	-$9	-$2	-$1	-$1	$0
Forest services	$4,096	$3,517	$3,139	$2,936	$2,783	$2,642
Desert services	$417	$356	$316	$295	$279	$264
Net capital growth	$401	$682	$1,690	$1,282	$1,267	$1,287
GPI	$20,699	$18,365	$17,746	$16,663	$16,447	$16,739

Table 66. Summary of GPI per-capita Results for Davis County, Utah

	1990	1995	2000	2003	2005	2007
Personal consumption	$17,687	$22,125	$29,668	$30,491	$33,409	$36,403
Income inequality	-$2,720	-$2,861	-$6,107	-$4,323	-$7,122	-$9,383
Personal consumption adjusted for income inequality	$14,967	$19,264	$23,561	$26,168	$26,287	$27,020
Household labor	$4,583	$4,407	$4,333	$4,553	$4,207	$4,222
Volunteer labor	$459	$442	$434	$665	$653	$589
Services of consumer durables	-$2,435	-$2,536	-$2,751	-$2,843	-$2,949	-$3,030
Streets and Highways	$102	$97	$121	$134	$145	$171
Crime	-$164	-$143	-$151	-$117	-$130	-$122
Family breakdown	-$261	-$232	-$239	-$246	-$210	-$184
Leisure time lost	-$1,716	-$2,238	-$2,109	-$1,814	-$1,880	-$2,075
Underemployment	-$375	-$476	-$494	-$816	-$672	-$576
Cost of consumer durables	-$2,081	-$2,406	-$3,501	-$4,054	-$4,423	-$4,784
Commuting	-$1,490	-$1,755	-$1,922	-$1,756	-$1,868	-$2,036
Pollution abatement	-$161	-$174	-$182	-$171	-$181	-$170
Vehicle crashes	-$635	-$787	-$638	-$591	-$551	-$626
Water pollution	$0	$0	$0	$0	$0	$0
Air pollution	-$87	-$100	-$70	-$74	-$80	-$72
Noise pollution	-$94	-$86	-$86	-$86	-$86	-$86
Wetland services	$1,510	$1,305	$1,162	$1,059	$993	$930
Farmland services	$303	$112	$179	$148	$130	$112
Nonrenewable resources	-$2,406	-$2,482	-$2,693	-$2,479	-$2,490	-$2,561
Climate change	-$739	-$1,022	-$1,426	-$1,510	-$1,767	-$1,849
Ozone depletion	-$44	-$9	-$2	-$1	-$1	$0
Forest services	$204	$177	$158	$144	$135	$127
Desert services	$31	$26	$23	$20	$19	$17
Net capital growth	$401	$682	$1,690	$1,282	$1,267	$1,287
GPI	$14,743	$17,137	$20,899	$23,302	$22,445	$22,365

Table 67. Summary of GPI per-capita Results for Salt Lake County, Utah

	1990	1995	2000	2003	2005	2007
Personal consumption	$18,169	$22,874	$30,449	$31,813	$36,291	$39,128
Income inequality	-$951	$3	-$1,912	-$3,268	-$3,482	-$1,946
Personal consumption adjusted for income inequality	$17,219	$22,877	$28,536	$28,546	$32,809	$37,182
Household labor	$5,566	$5,263	$5,155	$4,824	$4,971	$4,842
Volunteer labor	$500	$493	$499	$655	$682	$633
Services of consumer durables	$2,241	$2,334	$2,531	$2,616	$2,713	$2,788
Streets and Highways	$84	$81	$100	$102	$127	$151
Crime	-$300	-$311	-$253	-$273	-$264	-$263
Family breakdown	-$253	-$221	-$222	-$206	-$214	-$202
Leisure time lost	-$2,136	-$2,788	-$2,512	-$2,114	-$2,208	-$2,605
Underemployment	-$450	-$579	-$578	-$943	-$790	-$704
Cost of consumer durables	-$1,914	-$2,214	-$3,221	-$3,730	-$4,070	-$4,401
Commuting	-$1,691	-$1,967	-$1,978	-$1,762	-$1,886	-$2,143
Pollution abatement	-$175	-$166	-$157	-$157	-$169	-$165
Vehicle crashes	-$1,015	-$1,130	-$1,073	-$862	-$888	-$801
Water pollution	-$4	-$4	-$3	-$3	-$2	-$2
Air pollution	-$300	-$341	-$204	-$192	-$197	-$168
Noise pollution	-$94	-$86	-$86	-$87	-$87	-$87
Wetland services	$473	$462	$465	$470	$468	$464
Farmland services	$105	$55	$71	$65	$60	$55
Nonrenewable resources	-$2,113	-$2,199	-$2,431	-$2,344	-$2,404	-$2,525
Climate change	-$682	-$950	-$1,316	-$1,417	-$1,708	-$1,787
Ozone depletion	-$44	-$9	-$2	-$1	-$1	$0
Forest services	$169	$145	$129	$121	$115	$109
Desert services	$28	$23	$20	$18	$17	$15
Net capital growth	$401	$682	$1,690	$1,282	$1,267	$1,287
GPI	$15,616	$19,448	$25,160	$24,609	$28,343	$31,674

Table 68. Summary of GPI per-capita Results for Utah County, Utah (2000 USD)

	1990	1995	2000	2003	2005	2007
Personal consumption	$12,319	$16,337	$20,226	$19,888	$21,822	$23,003
Income inequality	-$1,190	-$1,540	-$1,762	-$1,727	-$2,328	-$2,156
Personal consumption adjusted for income inequality	$11,128	$14,796	$18,465	$18,161	$19,494	$20,847
Household labor	$5,464	$5,294	$4,930	$4,215	$4,207	$4,620
Volunteer labor	$401	$415	$406	$557	$594	$514
Services of consumer durables	$2,133	$2,221	$2,409	$2,490	$2,583	$2,654
Streets and Highways	$181	$159	$188	$177	$204	$233
Crime	-$150	-$155	-$118	-$111	-$117	-$97
Family breakdown	-$245	-$221	-$192	-$172	-$195	-$180
Leisure time lost	-$1,631	-$2,164	-$2,018	-$1,622	-$1,678	-$1,852
Underemployment	-$350	-$455	-$469	-$727	-$601	-$514
Cost of consumer durables	-$1,822	-$2,108	-$3,066	-$3,551	-$3,874	-$4,190
Commuting	-$1,305	-$1,528	-$1,600	-$1,494	-$1,517	-$1,643
Pollution abatement	-$167	-$195	-$208	-$182	-$142	-$132
Vehicle crashes	-$805	-$1,004	-$888	-$727	-$693	-$644
Water pollution	-$3	-$3	-$4	-$4	-$3	-$3
Air pollution	-$74	-$86	-$81	-$51	-$57	-$52
Noise pollution	-$94	-$86	-$82	-$82	-$82	-$82
Wetland services	$1,239	$1,184	$1,090	$1,011	$972	$914
Farmland services	$1,046	$498	$703	$606	$555	$498
Nonrenewable resources	-$2,251	-$2,281	-$2,296	-$2,026	-$2,005	-$1,995
Climate change	-$653	-$958	-$1,234	-$1,250	-$1,417	-$1,483
Ozone depletion	-$44	-$9	-$2	-$1	-$1	$0
Forest services	$2,035	$1,716	$1,410	$1,227	$1,131	$1,022
Desert services	$251	$213	$175	$153	$141	$128
Net capital growth	$401	$682	$1,690	$1,282	$1,267	$1,287
GPI	$14,687	$15,924	$19,208	$17,880	$18,767	$19,849

Table 69. Summary of GPI per-capita Results for Washington County, Utah (2000 USD)

	1990	1995	2000	2003	2005	2007
Personal consumption	$10,154	$12,737	$15,617	$15,625	$17,842	$18,550
Income inequality	$837	$891	$646	$1,338	-$179	$915
Personal consumption adjusted for income inequality	$10,991	$13,627	$16,264	$16,963	$17,663	$19,465
Household labor	$6,011	$5,487	$5,551	$5,264	$5,112	$5,040
Volunteer labor	$476	$470	$496	$583	$651	$600
Services of consumer durables	$1,670	$1,739	$1,887	$1,950	$2,022	$2,078
Streets and Highways	$620	$452	$479	$426	$439	$513
Crime	-$163	-$198	-$216	-$114	-$177	-$139
Family breakdown	-$239	-$208	-$249	-$223	-$222	-$205
Leisure time lost	-$1,318	-$1,844	-$1,636	-$1,405	-$1,465	-$1,826
Underemployment	-$286	-$390	-$381	-$644	-$547	-$478
Cost of consumer durables	-$1,427	-$1,650	-$2,401	-$2,780	-$3,034	-$3,281
Commuting	-$1,288	-$1,534	-$1,560	-$1,485	-$1,547	-$1,810
Pollution abatement	-$158	-$147	-$146	-$146	-$155	-$142
Vehicle crashes	-$882	-$798	-$767	-$935	-$803	-$781
Water pollution	-$3	-$3	-$1	-$2	-$2	-$1
Air pollution	-$27	-$40	-$36	-$53	-$76	-$52
Noise pollution	-$94	-$73	-$70	-$70	-$70	-$70
Wetland services	$3,576	$2,274	$1,717	$1,374	$1,157	$1,017
Farmland services	$269	$133	$181	$159	$142	$133
Nonrenewable resources	-$3,463	-$2,750	-$2,659	-$2,215	-$2,041	-$2,014
Climate change	-$693	-$961	-$1,227	-$1,265	-$1,472	-$1,540
Ozone depletion	-$44	-$9	-$2	-$1	-$1	$0
Forest services	$11,095	$7,425	$5,919	$4,901	$4,225	$3,806
Desert services	$2,556	$1,716	$1,372	$1,138	$982	$885
Net capital growth	$401	$682	$1,690	$1,282	$1,267	$1,287
GPI	$27,580	$23,399	$24,204	$22,703	$22,049	$22,487

Table 70. Summary of GPI per-capita Results for Weber County, Utah (2000 USD)

	1990	1995	2000	2003	2005	2007
Personal consumption	$15,164	$18,383	$22,145	$24,234	$25,987	$28,464
Income inequality	-$141	-$689	-$1,781	-$1,746	-$1,375	-$1,295
Personal consumption adjusted for income inequality	$15,023	$17,693	$20,364	$22,488	$24,612	$27,169
Household labor	$5,201	$4,893	$4,645	$4,523	$4,422	$4,521
Volunteer labor	$499	$491	$485	$583	$675	$618
Services of consumer durables	$1,917	$1,997	$2,166	$2,239	$2,322	$2,386
Streets and Highways	$133	$130	$148	$157	$192	$228
Crime	-$246	-$268	-$217	-$229	-$176	-$240
Family breakdown	-$251	-$224	-$251	-$245	-$238	-$220
Leisure time lost	-$1,903	-$2,432	-$2,195	-$1,913	-$1,933	-$2,216
Underemployment	-$399	-$503	-$502	-$854	-$697	-$603
Cost of consumer durables	-$1,638	-$1,894	-$2,756	-$3,192	-$3,482	-$3,766
Commuting	-$1,458	-$1,676	-$1,725	-$1,603	-$1,610	-$1,835
Pollution abatement	-$177	-$158	-$140	-$151	-$154	-$151
Vehicle crashes	-$873	-$986	-$912	-$862	-$841	-$810
Water pollution	-$3	-$3	-$2	-$2	-$2	-$4
Air pollution	-$94	-$105	-$84	-$66	-$68	-$61
Noise pollution	-$94	-$84	-$81	-$82	-$82	-$82
Wetland services	$2,336	$2,169	$2,035	$1,998	$1,954	$1,919
Farmland services	$567	$287	$376	$338	$311	$287
Nonrenewable resources	-$1,959	-$2,061	-$2,241	-$2,161	-$2,222	-$2,352
Climate change	-$719	-$964	-$1,208	-$1,362	-$1,568	-$1,641
Ozone depletion	-$44	-$9	-$2	-$1	-$1	$0
Forest services	$812	$723	$652	$625	$602	$583
Desert services	$76	$67	$60	$57	$55	$53
Net capital growth	$401	$682	$1,690	$1,282	$1,267	$1,287
GPI	$17,108	$17,765	$20,302	$21,567	$23,335	$25,071